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MINISTRY OF HOUSING AND URBAN AFFAIRS
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सत्यमेव जयते

स्वच्छ भारत
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Reference Guide

Business Models and Economic Assistance for Municipal Solid Waste (MSW) Projects

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CONTENTS

ACRONYMS AND ABBREVIATIONS

APM	Administrative Price Mechanism
BOO	Build, Own, Operate
BRPL	BSES Rajdhani Power Limited
BWG	Bulk Waste Generator
CBG	Compressed Biogas
CDM	Clean Development Mechanism
CDW	Construction and Demolition waste
CEMS	Continuous Emission Monitoring System
CERC	Central Electricity Regulatory Commission
CGD	City Gas Distribution
CNG	Compressed Natural Gas
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CPI	Consumer Price Index
CSWAP	City Solid Waste Action Plan
CTE	Consent To Establish
CTO	Consent To Operate
DBFO	Design Build, Finance, Operate
DBFOT	Design Build, Finance, Operate, Transfer
DBOOT	Design Build, Own, Operate, Transfer
DBT	Direct Benefit Transfer
DISCOM	Distribution Company
DPR	Detailed Project Report
DST	Department of Science and Technology (Government of India)
EAT	Expenditure, Advance, and Transfer
EOI	Expression of Interest
EPC	Engineering, Procurement, Construction
EPR	Extended Producer Responsibility
FOM	Fertilized Organic Manure
GAIL	Gas Authority of India Limited
GHG	Greenhouse Gases
GOI	Government of India
GSDP	Gross State Domestic Product
GST	Goods and Service Tax
GTS	Garbage Transfer Stations
HERC	Haryana Electricity Regulatory Commission
IFC	International Finance Corporation
IFD	Integrated Finance Division
IIFCO	Indian Farmers Fertilizer Cooperative
ISWM	Integrated Solid Waste Management
KWH	Kilowatt Hours
LOI	Letter of Intent
LTOA	Long term Open Access
MCF	Million Plus Cities Challenge Fund
MMBTU	Metric Million British Thermal Unit
MMT	Million Metric Tonnes
MNRE	Ministry of New and Renewable Energy
MOHUA	Ministry of Housing and Urban Affairs
MRF	Material Recovery Facility
MSME	Micro, Small and Medium Enterprise
MSW	Municipal Solid Waste
NAPM	Non-Administrative Price Mechanism
NARC	National Advisory and Review Committee
NDMC	New Delhi Municipal Council
NHB	National Housing Bank
NOIDA	New Okhla Industrial Development Authority
OBI	Output Based Incentive
OMC	Oil Marketing Companies

OPEX	Operational Expenditure
PAWTE	Plasma Arc Waste to Electricity
PCMC	Pimpri-Chinchwad Municipal Corporation
PFMS	Public Financial Management System
PMC	Pune Municipal Corporation
PNB	Punjab National Bank
PNG	Petroleum and Natural Gas
PPA	Power-Purchase Agreement
PPP	Public-Private Partnership
QCBS	Quality and Cost Based Selection
RDF	Refuse-Derived Fuel
RSP	Retail Selling Price
SATAT	Sustainable Alternatives for Affordable Transportation
SBI	State Bank of India
SBM	Swachh Bharat Mission
SFC	State Finance Commission
SHPC	State High Powered Committee
SLF	Sanitary Landfill
SLTC	State Level Technical Committee
SPCB	State Pollution Control Board
SPV	Special Purpose Vehicle
STP	Sewage Treatment Plant
SWM	Solid Waste Management
TIFAC	Technology Information, Forecasting and Assessment Council
TPD	Tonnes Per Day
TPDDL	Tata Power DDL
UASB	Up-flow Anaerobic Sludge Blanket
UIDF	Urban Infrastructure Development Fund
ULB	Urban Local Body
VGF	Viability Gap Funding
WBG	World Bank Group
WPI	Wholesale Price Index
WTE	Waste to Electricity
YOY	Year on Year

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EXECUTIVE SUMMARY

About this document

The Ministry of Housing and Urban Affairs (MoHUA) has signed an agreement with the International Finance Corporation (IFC), a member of the World Bank Group to accelerate investments in the Municipal Solid Waste (MSW) sector in India. Under this partnership, IFC assisted MoHUA in preparing a Reference Guide on business models and government economic assistance programmes for MSW in India for Urban Local Bodies (ULBs) to design and develop sustainable MSW projects. KPMG has been appointed as the consultant by IFC to develop this Reference Guide.

This Reference Guide offers strategic insights and practical guidance for implementing **business models** in **MSW processing specifically in Waste to Electricity (WTE), Bio-methanation, Bioremediation, and allied approaches** (including **Recycling, Composting, Construction & Demolition waste**). Additionally, it explores the various **economic assistance** programmes of the Government of India (GoI) for MSW projects.

Business models for MSW processing

Growing consumption driven by India's economic growth and urbanization is translating to a surge in MSW generation across urban India. This presents a significant challenge for Urban Local Bodies (ULBs) to develop adequate infrastructure, technical expertise and human resources to manage this increasing waste volume in an environmentally sustainable and economically efficient manner.

India's MSW generation of **~55 million tonnes** in 2023 is projected to increase three times to **165 million tonnes** by 2030 and potentially to **436 million tonnes** by 2050[1]. Additionally, the country grapples with ~**250 million tonnes** of untreated legacy waste across **~2300 dumpsites**[2]. Managing this growth of MSW sustainably and efficiently, requires redoubling efforts towards waste minimization, segregation, scientific processing and recycling, while creating capacities for safe, efficient utilization of RDF and disposal of processing rejects from legacy waste remediation projects at the landfill sites. ULBs will need to play a pivotal role in this regard.

Although installed processing capacity of MSW is reported at ~130% of waste generation, many facilities are operating at only 50-60% of their designed capacity. Over half of this processing capacity is dedicated to composting organic waste. As land scarcity intensifies and waste characteristics change, ULBs must adopt more advanced processing technologies, such as Waste-to-Electricity, Bio-methanation, and Material Recovery Facilities (MRFs), to maximize resource recovery from MSW and minimize waste diversion to dumpsites or landfills.

The Government of India's initiatives in the recent years have been encouraging. In 2016, the Solid Waste Management Rules were revised along with fresh guidelines for management of plastic waste, and Construction & Demolition (C&D) waste. The second phase of Swachh Bharat Mission (Urban) (SBM-U 2.0) (2021-26) focuses on making all Indian cities garbage-free. The Swachh Survekshan (an annual nationwide survey of ULBs on sanitation and waste management parameters conducted by an Independent Verification Agency for MoHUA) assesses the performance of the cities including on waste management. Furthermore, the Sustainable Alternative Towards Affordable Transportation (SATAT) scheme provides a guaranteed market for compressed biogas, making such projects viable and bankable. Some, salient facets of the business models documented in the Guide are summarized below.

[1] SBM 2.0 Operational Guidelines, Ministry of Housing and Urban Affairs, 2021
[2] CPCB annual report 2021-22

Waste-to-Electricity

Waste-to-Electricity (WtE) model is **land-efficient** and helps achieve the highest waste minimization among available processing options while creating a revenue stream through energy recovery. Due to its significantly lower land footprint, WtE model is ideally suited for large, densely populated ULBs including clusters of ULBs with waste generation greater than 500 TPD and limited land availability. A 2014 GoI task force report noted that there is a potential power generation of ~**439 MW** from processing ~**32,890 tonnes of MSW per day** in the immediate term (5-7 years). In the long term, WtE projects could generate power up to 2,780 MW. Comparatively, WtE projects entail much higher capital costs, greater technical sophistication, and stringent emissions management. All the WtE projects are required to a conduct Public hearing to address the concerns of all the stakeholders and incorporate the mitigative measures in the final project report for obtaining EC

WASTE-TO-ELECTRICITY – Salient highlights from operational projects

SCALE, CONFIGURATION AND PROJECT COSTS

- Incineration based projects requiring segregated, pre-processed waste/RDF with caloric value > 1,500 Kcal
- Power generation potential : 1-1.5 MW/100 TPD MSW
- Land requirement : 1.5 Acres /100 Tonnes of MSW to be processed
- CAPEX/OPEX range
  - INR 15-25 Cr per MW
  - INR 23-29 Cr per 100 TPD

SCOPE, IMPLEMENTATION MODE, PROJECT STRUCTING AND BID VARIABLE

- Implementation mode: PPP (DBFOT/DBFO)
- **Integrated** (collection, transportation, processing, disposal in SLF by developer) or **processing only** models
- Bid variables: Tariff/ Processing or tipping fee/VGF/ Output Based Incentive (OBI)

FINANCING MIX, REVENUE STREAMS AND COMMERCIAL VIABILITY

- Financial Viability determinants- VGF grants, sale of power and additional revenue streams
- Revenue streams
  - Sale of power
  - Processing/Tipping Fee
  - Carbon credits
  - Renewable Energy Certificates

ENABLING CONDITIONS

- Assured availability of waste (500 TPD and above)
- Land parcel availability
- Compliance to enviornment and social safeguards
- Revenue assurance via Power Purchases Agreements
- Payment security to developers

Bio-methanation

Bio-methanation is **environmentally efficient** and enables the capture of methane from organic waste and the production of Compressed Biogas (CBG), a fossil-fuel alternative. GoI estimates that 15,000 tonnes of daily waste can yield 500 to 600 tons of CBG per day through biomethanation with a revenue potential of approx.. INR 1,000 crore annually by 2030.

BIOMETHANATION – Salient highlights from operational projects

SCALE, CONFIGURATION AND PROJECT COSTS

- Based on anaerobic digestion of organic MSW
- Generation potential: 30-35 kgs/Tonne of MSW
- Land requirement: 5-6 acres for 100 TPD including pre-processing area and FOM/ LFOM processing area
- CAPEX/OPEX range
  - INR 30-35 Cr per 100 TPD processing capacity

SCOPE, IMPLEMENTATION MODE, PROJECT STRUCTING AND BID VARIABLE

- Implementation mode: PPP (DBFOT)
- EPC mode for smaller projects
- Concession period upwards of 20 years
- Bid variables: Highest royalty to ULBs for providing MSW at source, Processing/Tipping fee, Lowest VGF based

FINANCING MIX, REVENUE STREAMS AND COMMERCIAL VIABILITY

- Financial Viability determinants- VGF grants and additional revenue streams
- Revenue streams
  - Sale of CBG
  - Sale of Fertilized Organic Manure and Slurry
  - Processing/Tipping Fee

ENABLING CONDITIONS

- Assured availability of high-quality source segregated MSW
- Identification of feedstock clusters
- Pre-processing of MSW for consistant feedstock
- Availability of land parcels
- Off-take commitments
- Bankability of projects

There are 114 operational plants in urban India with a daily processing capacity of ~3,500 TPD. Seven of these plants are of medium to large size with processing capacities ranging from 50 TPD to 550 TPD. The availability of segregated biodegradable waste is a prerequisite for successful bio-methanation projects.

Bioremediation

Recognizing the urgent need to mitigate the negative impacts of decades of unscientific waste management on public health and the environment, the Government of India is prioritizing bioremediation of legacy dumpsites (2,300 dumpsites containing ~250 million tonnes of legacy MSW).

India has set ambitious targets to eliminate these dumpsites by October 2024 for cities with populations under one million and by March 2026 for million-plus cities. The government provides Central Financial Assistance of Rs. 550 per tonne for legacy waste processing under SBM-U 2.0. Furthermore, the SWM Rules 2016 identify bioremediation as a preferred option for managing legacy waste, while advocating waste capping for residual waste after waste recovery through bioremediation.

BIOREMEDIATION – Salient highlights from operational projects

SCALE, CONFIGURATION AND PROJECT COSTS

- Primary means of remediation-Biomining and capping
- Scale of projects: Between 1,000- 2 Cr Metric Tonnes
- CAPEX/OPEX range
  - INR 360-1150 PROCESSING costs per tonne of MSW

SCOPE, IMPLEMENTATION MODE, PROJECT STRUCTING AND BID VARIABLE

- Implementation mode: EPC
- Bid variables: Lumpsum project cost based, Processing/Tipping fee

FINANCING MIX, REVENUE STREAMS AND COMMERCIAL VIABILITY

- Financial Viability determinants- VGF grants and additional revenue streams
- Revenue streams
  - Sale of by-products (plastic, Rubber, Metal, Textiles, Glass, construction and demolition (C&D), good earth/soil and inert)
  - Processing/Tipping Fee

ENABLING CONDITIONS

- Assured estimation and quantification of waste
- Restricting fresh dumping of waste in the designated area
- Bi-furcated cost of processing and disposal
- Off-take commitments for RDF
- Sustainable disposal of inerts

Allied approaches

Construction & Demolition waste management

Construction and Demolition (C&D) waste accounts for nearly a quarter of Municipal Solid Waste (MSW) generated in India's million-plus cities. Despite an estimated 12 million tonnes of C&D waste being generated annually, less than 20-40% of it is processed. While India has 993 C&D waste processing facilities with a combined design capacity of approximately 45,000 tonnes, their operational efficiency ranges from 60-70%. C&D waste recycling offers a viable and cost-effective alternative to traditional multi-treatment and processing methods by reducing energy and tipping costs. However, due to limited infrastructure and inefficient waste collection, C&D waste is often disposed of indiscriminately and insufficiently processed or recycled. Given the anticipated increase in construction activities, expanding C&D processing facilities will be crucial for promoting sustainable resource use in the construction sector.

Recycling via Material Recovery Facilities (MRFs)

MRFs are intermediate facilities in the MSW value chain that receive, sort, and store recyclables for further processing, recovery, and reuse. They can be standalone structures or integrated into comprehensive waste management systems, often offering greater commercial viability. Given the limited prevalence of source segregation, MRFs are increasingly essential as a preprocessing step for other waste management processes, such as bio-methanation and Waste to Electricity.

Composting

Composting is a **cost-effective** method for managing biodegradable Municipal Solid Waste (MSW). An estimated 75,000 tonnes per day (TPD) of wet waste is generated daily, of which nearly a quarter remains untreated. Under SBM 2.0, plans are in place to develop 45,000 TPD of wet waste processing capacity, comprising 30,800 TPD of compost plants and the remainder as bio-methanation facilities. Although composting offers lower operational and maintenance (O&M) costs and requires less specialized skills, it demands significant land area. Revenue generation from composting projects often falls short of covering costs. In some cities, compost plants operate as standalone projects. These can be implemented through Public-Private Partnerships (PPPs), a combination of Engineering, Procurement, and Construction (EPC) and O&M contracts, or solely as O&M service contracts if the compost plant already exists.

Allied approaches: Salient highlights from operational projects

SCALE, CONFIGURATION AND PROJECT COSTS

- Type of projects
  - C&D waste - Integrated Facilities
  - Composting- Windrow
  - MRFs- Automated/semi-automated;/manual
- Land requirements (per 100 TPD)
  - C&D Waste - 1.5 acre
  - Composting 5-6 acre
  - MRFs 1.5-2 acre
- CAPEX range
  - C&D waste - 6.5 Cr for 1,00 TPD
  - Composting - 11.5 cr for 100 TPD
  - Automated MRFs - 20Cr for 100 TPD

SCOPE, IMPLEMENTATION MODE, PROJECT STRUCTING AND BID VARIABLE

- Implementation mode:
  - C&D waste : PPP (DBOOT)
  - Composting : PPP (DBFOT)
  - MRFs : PPP (EPC + Q&M)
- Bid variables:
  - Processing/Tipping fee based
  - VGF based

FINANCING MIX, REVENUE STREAMS AND COMMERCIAL VIABILITY

- Financial Viability determinants- VGF grants and additional revenue streams
- Revenue streams
  - Sale of by-products
  - Processing/Tipping Fee

ENABLING CONDITIONS

- Creation and availability of markets for recycled products
- Accurate preparation of DPRs
- Undertaking robust monitoring
- Availability of source segregated waste
- Availability of land parcels
- Investments into R&D that maximise resource recovery
- Sustainable post-recycling marketing strategy

In conclusion, all waste processing options involve trade-offs in terms of land requirements, ecological footprint, and cost-effectiveness. A one-size-fits-all approach is neither feasible nor desirable. Urban Local Bodies (ULBs) must carefully plan waste processing facilities, considering various trade-offs and city-specific factors.

This Reference Guide provides comprehensive information on different MSW processing options. It includes concise overviews, common implementation models, revenue streams, and key success factors for each approach. Additionally, the guide presents case studies of operational projects, highlighting project scale, costs, revenue generation, implementation models, and critical factors for success.

Economic assistance

The Reference Guide also aims to outline the nature and extent of economic assistance available for MSW projects under various government direct financing schemes and enabling programs.

- **Direct Financing:** In this case, economic assistance is provided through capital grants under various Government of India (GoI) schemes and initiatives. This guide profiles four such programs:
  - Swachh Bharat Mission (Urban) (SBM-U 2.0)
  - 15th Finance Commission (XV-FC) Grant
  - Urban Infrastructure Development Fund

[3]Sbmurban.org (Mission Progress)

- City Investments to Innovate, Integrate, and Sustain (CITIIS 2.0) initiative under the Ministry of Housing and Urban Affairs, Government of India.
- Urban Challenge Fund

- **Enabling schemes:** These economic assistance schemes do not provide direct grants but support MSW management through enabling policies that foster favorable market conditions and linkages. The instruments profiled in this category include:
  - Sustainable Alternatives for Affordable Transportation (SATAT)
  - Extended Producer Responsibility (EPR)
  - National Tariff Policy 2016 and Tariff Regulations for MSW and biogas-based power generation

Table 1 Economic assistance for MSW projects

S.No.	Scheme/Policy	Nodal Dept./ Agency	MSW sub-sectors covered	Salient features
Direct Financing Schemes				
1	**Swachh Bharat Mission (Urban)**	Ministry of Housing and Urban Affairs, GoI	• Waste to Electricity • Bio-methanation • Bioremediation • Composting • Recycling • C&D waste management	• **Scheme covers all statutory towns and ULBs of India** • **Tenure**: 2021-2026 • **Central Financial Assistance as Viability Gap Funding for MSW projects** • **INR 10,168 Cr** quantum allocated as CFA • Gap analysis-based City Solid Waste Action Plans prepared by cities which are then approved by the State and MoHUA to release funding
2	**15th Finance Commission Grants** **Million-Plus Cities Challenge Fund**	Dept of Expenditure (Finance Commission Division) Ministry of Finance, GoI	• Waste to Electricity • Bio-methanation • Bioremediation • Composting • Recycling • C&D waste management	• **Grants-in-aid for ULBs (including urban agglomerations)** • **Tenure**: 2021-2026 • **Challenge Fund** – Performance linked grants for improving urban MSW in Million Plus population cities – **INR 38, 196 Cr** • **Tied and untied grants for Non-Million Plus Cities** covering Solid Waste Management projects – **INR 82,859 Cr** • Eligibility for challenge fund grants for Million Plus Cities based on performance assessment across indicators and Star Rating Protocol for Garbage Free Cities • Eligibility for tied grants for Non-Million Plus Cities based on baseline data, annual targets, and achievements
3	**Urban Infrastructure Development Fund**	National Housing Bank	• Waste to Electricity • Bio-methanation • Bioremediation • Composting • Recycling • C&D waste management	• **Loan based financing to States/UTs** • **Tenure**: 2023 onwards • **MSW projects in Tier 2 and 3 cities supported** • Overall annual corpus of fund: **INR 10,000 Cr** • Proposals to be developed and submitted • via State/UT governments for availing loans
4	**CITIIS 2.0**	Ministry of Housing and Urban Affairs	• Thrust on Circular economy with focus on integrated waste management	• **Component 1- City level interventions focus primarily on Integrated waste management:** Financial and technical support to up to 18 smart cities through selection of competitively selected projects promoting circular economy with focus on integrated waste management • Loan based financing to States/UTs. Loan of Rs.1760 crore (EUR 200 million) from AFD and KFW (EUR 100 million each) and a technical assistance grant of Rs.106 cr. • (EUR 12 million) from the EU.

S.No.	Scheme/Policy	Nodal Dept./ Agency	MSW sub-sectors covered	Salient features
Direct Financing Schemes				
5	**Urban Challenge Fund**	Ministry of Housing and Urban Affairs	• Various urban development projects, including city redevelopment, infrastructure projects, and water and sanitation improvements	• **Loan based finacing to cities covering 25% of the total cost** • **Tenure:** 5 Years • Total allocation : **INR 10,000 Cr** • At least 50 percent of the project funding must come from bonds, bank loans, or public-private partnerships (PPPs)

S.No.	Scheme/Policy	Nodal Dept./Agency	MSW sub-sectors covered	Salient features
Enabling policies and schemes				
6	**Sustainable Alternatives for Affordable Transportation (SATAT)**	Ministry of Petroleum and Natural Gas, GoI	• Bio-methanation	• Central Financial Assistance for setting up Bio-CBG plants by Ministry of New and Renewable Energy, GoI • **Assured long-term floor pricing** and EOI based commercial agreements for off-take commitments by Oil Marketing Companies for Bio-CBG produced • **Priority Sector Lending**: Public Sector Bank loans for setting up Bio-CBG plants • Role of MoPNG is to set up bio-CBG plants through OGMCs and buying CBG under SATAT scheme. MNRE provides financial assistance under the Waste to Energy Programme on Energy from Urban, Industrial and Agricultural Wastes/Residues‖ under the umbrella • scheme of National Bioenergy Programme for duration 2021-22 to 2025-26
7	**Extended Producer Responsibility**	Ministry of Environment, Forests and Climate Change, GoI	• Recycling	• Policy and regulatory support mandating, incentivizing, and penalizing various sets of activities for holistic plastic waste management and processing by Producers, Importers, Brand Owners, and Processors • Facility to generate EPR surplus certificates and carry forward, off-set EPR obligations • via sale and purchase of certificates
8	**Tariff Policy 2016** **Tariff Regulations for MSW and Biogas based power generation**	Ministry of Power, GoI Central Electricity Regulatory Commission	• Waste to Electricity • Bio-methanation	• Policy measure ensuring assured procurement of power generation viz. Waste to Electricity projects • Regulatory orders outlining the methodology and parameters guiding the calculation and determination of tariffs for various projects related to MSW, RDF and • Bio-CBG/Biogas based power generation

1

ABOUT THIS REFERENCE GUIDE

1.1 Background[4]

The Ministry of Housing and Urban Affairs (MoHUA) has partnered with the International Finance Corporation (IFC), a member of the World Bank Group, to accelerate investment in the Municipal Solid Waste (MSW) sector in India. Through this partnership, IFC has assisted MoHUA in developing a reference guide on business models and economic assistance for MSW, intended for use by Urban Local Bodies (ULBs) in developing MSW projects in India. IFC appointed KPMG as the consultant to draft, revise, and finalize this Reference Guide and a related guidance note. KPMG drafted and revised the Reference Guide based on instructions, comments, feedback, and other information received from IFC and MoHUA.

The objective of this Reference Guide is to provide practical guidance to ULB practitioners on Waste to Electricity (WTE), bio-methanation, bio-mining, and allied approaches (including recycling, composting, and construction & demolition waste management). It builds upon a review of operational MSW projects in these areas across the country. Additionally, it includes a primer on economic assistance and potential financing options available under various Government of India (GoI) initiatives for MSW projects.

1.2 Scope of this Reference Guide

The Reference Guide aims to provide practical guidance to city officials and MSW practitioners on business models for implementing MSW processing projects and on economic assistance available from GoI programs. It aligns with the objectives of SBM-U, which focus on 100% scientific management of MSW and the remediation and conversion of legacy dumpsites into green zones. Consequently, the scope of the reference guide encompasses:

i. Guidance on business models for MSW processing projects

ii. Profiles of select GoI programs offering economic assistance

1.2.1 Guidance on business models for MSW processing

The guidance on business models focuses on the following waste processing and recycling approaches:

- Waste to Electricity (WTE)
- Bio-methanation
- Bioremediation
- Allied Approaches- Construction & Demolition (C&D) waste, Composting and Material Recovery Facilities

Refer to *Exhibit 1.1* for a snapshot of the thematic aspects covered under guidance on business models and *Exhibit 1.2* for a select list of potential revenue streams seen for MSW projects. The content has been developed through desk research of selected operational and under-implementation MSW projects in specific Indian cities, supplemented by interviews with city officials and project developers.

Refer to *Annexure B* for a list of projects profiled during preparation of this Guide.

[4] This background section is for the benefit of MoHUA, any urban local body or other authority using or reviewing the Reference and the Guidance Note.

Exhibit 1.1 Guidance on Business models – Thematic coverage

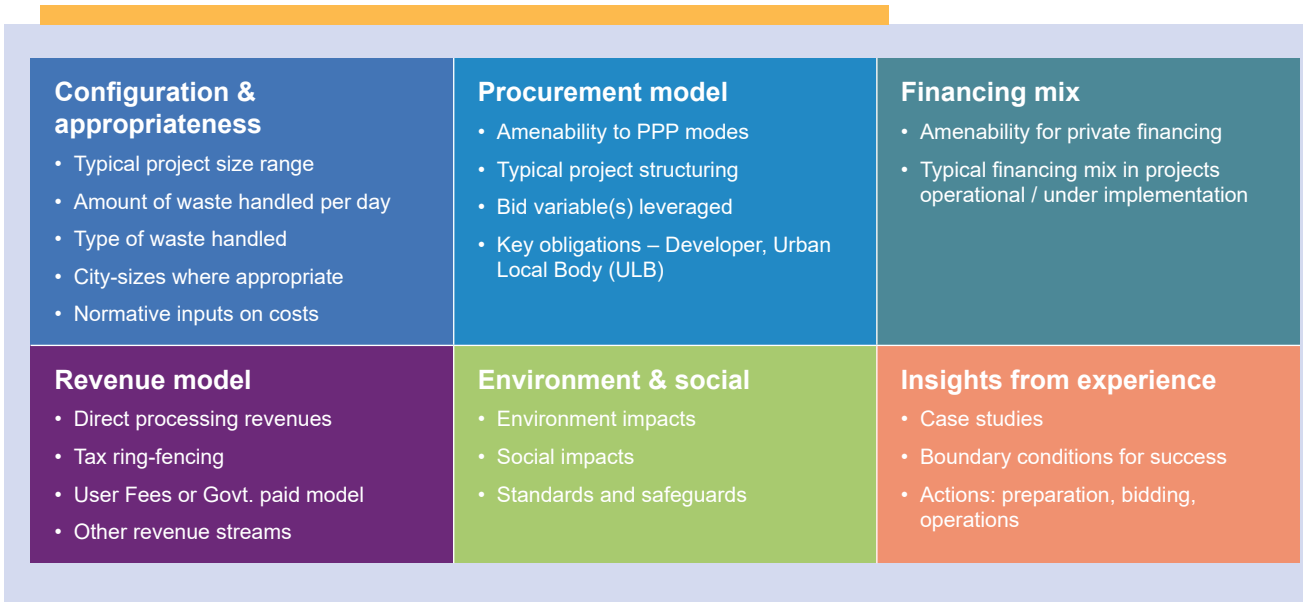
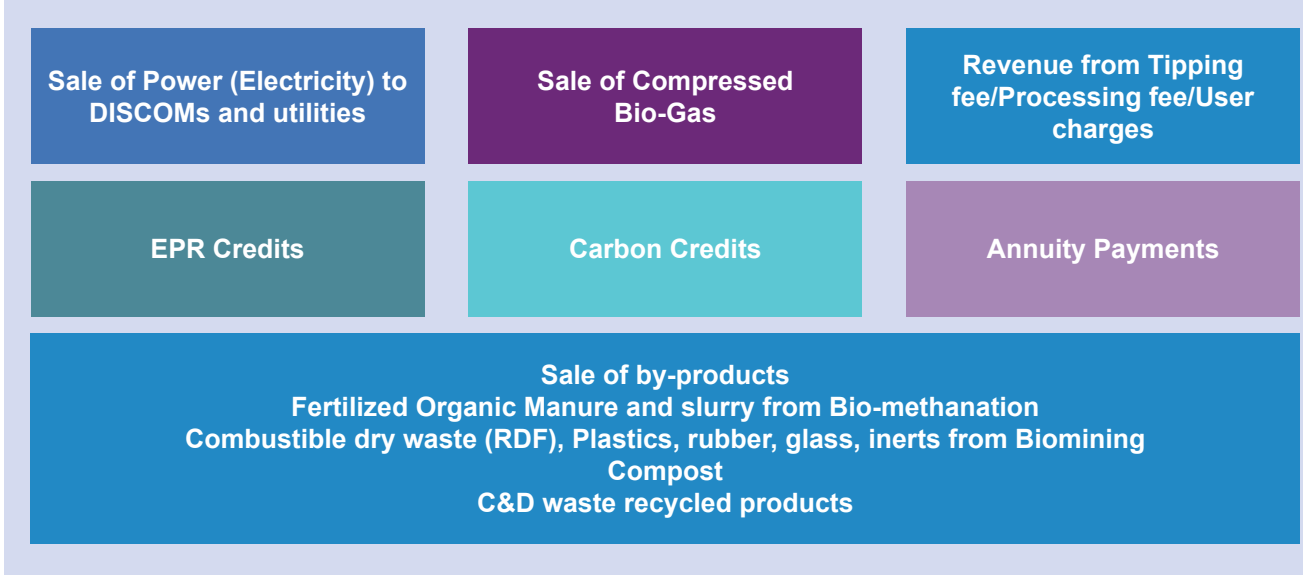


Exhibit 1.2 Guidance on Business models – List of potential revenue streams for MSW projects



1.2.2 Review of economic assistance

The guidance on economic assistance provides a mapping of existing rules, policies, and guidelines for GoI schemes and programs that offer economic assistance for MSW projects focusing on waste processing and recycling approaches covered in this document.

The guidance covers the type of support, eligibility criteria for support, budgetary outlay for support (where applicable), and implications for project implementation in terms of how this economic assistance will contribute to project viability and sustainability. It is categorized into two types: (i) **Schemes with direct budgetary support**, and (ii) **Schemes providing enablers for financing, rather than direct budgetary support**.

Exhibit 1.3 summarizes the criteria adopted for the analysis of the select GoI policies, schemes and rules covered.

Exhibit 1.3 Guidance on Economic Assistance – criteria for selection of GOI schemes and programs

Type of Support	Eligible projects	Process of availing assistance
• Scale of support • Central assistance/Loans	• Pre-requisites • Minimum population • Type of processing	• Rationale for economic assistance • Approval Process

1.3 Organization and content

The Reference Guide is organized along the following sections:

- **Section 2 Business Models** provides thematic insights around options available to cities to process MSW. This section is organized in five chapters:
  - **Chapter 2 Market context** traces the drivers underlying the rapid growth in MSW generation in India and discusses the critical imperative of scaling up MSW processing. It provides an overview of different MSW processing options discussed in this Reference Guide, and how they fit in with different waste categories.
  - **Chapters 3 – 6** cover **Waste to Electricity, Bio-methanation, Bioremediation** and **Allied approaches-Recycling, Composting and C&D waste processing** respectively. These chapters distil insights and practical guidance on business models underpinning respective processing approaches. They cover typical project sizes & configuration, procurement models, financing mix, revenue streams and boundary conditions for success.
- **Section 3 Economic assistance** discusses select GoI schemes under which economic assistance is being made available for MSW projects and is organized in three chapters:
  - **Chapter 7 Section background** discusses the rationale for economic assistance for MSW projects.
  - **Chapter 8 Direct financing schemes** covers financing schemes under which direct financing in the form of grants are made available from GoI budgetary outlays.
  - **Chapter 9 Enabling schemes** covers schemes and initiatives under which financing is enabled through policy actions and guidelines instead of deploying capital grants from budgetary outlays.

SECTION 2
BUSINESS MODELS

2 MARKET CONTEXT

2.1 Outlook for MSW generation

India's cities and towns generate ~55 million tonnes[5] of MSW annually (or ~1.5 lakh tonnes per day). In the coming decades, rising income levels and intensifying urbanization are expected to drive a further increase in per capita waste generation, as well as a shift in MSW composition toward a higher share of non-biodegradable waste. MSW generation is projected to increase to 165 million tonnes by 2030 and 436 million tonnes by 2050[6]. Already legacy waste of ~ 250 million tonnes dumped at over 2300 sites across the country pose significant public health and environmental challenges.

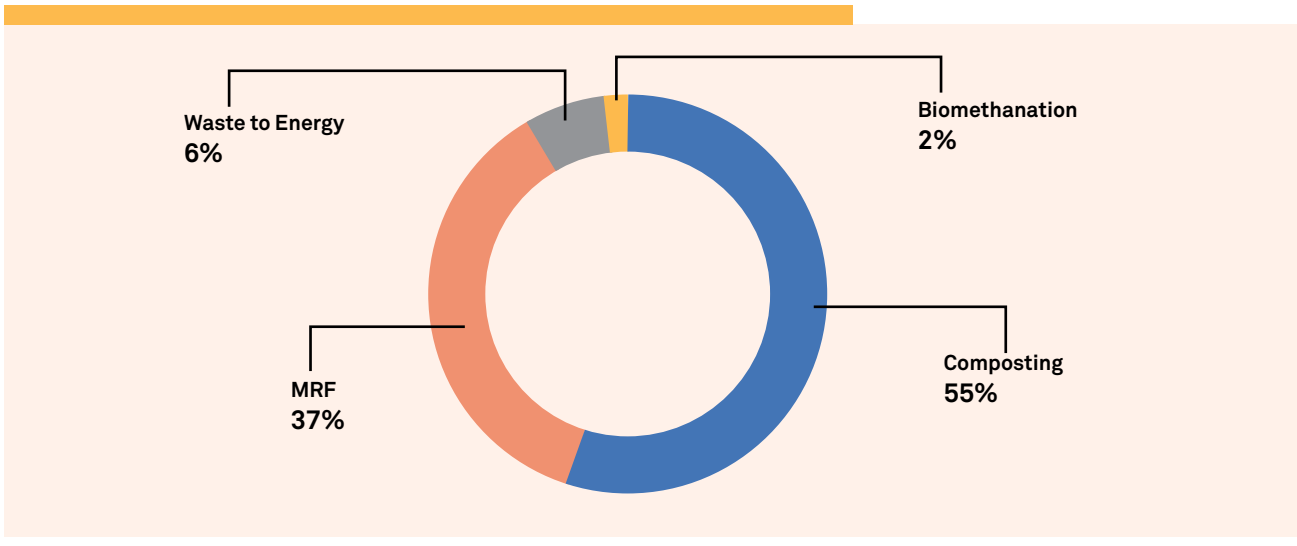
A status quo approach for managing MSW is therefore clearly not sustainable. An accelerated expansion of waste processing & recycling capacities together with expeditious bioremediation of legacy dumpsites is therefore critical to engender sustainable MSW management in Indian cities and is crucial to the health, hygiene, and social well-being of India's urban populace.

The second phase of Swachh Bharat Mission (Urban) (SBM (U) 2.0) recognizes these imperatives and specifically targets both, namely, (i) creation of MSW processing capacity and (ii) bioremediation of legacy waste and conversion of existing dumpsites into green areas.

2.2 Prevalent MSW processing capacity

MSW designed processing capacity stood at a reported 205,000 TPD[7] (~ 130% of estimated waste generation i.e. ~150,000 TPD). Of this, ~112,000 TPD (55%) was in the form of composting. Other approaches namely, Bio-methanation (3500 TPD), Waste to Electricity (14,200 TPD) and Material Recovery Facilities (75,000 TPD) accounted for the reminder 45% share. (Also refer to *Exhibit 2.1*). The operational efficiency of these plants is in the range of 50%-60% i.e., 100,000 to 120,000 TPD. The total waste getting processed is 76% i.e. 114,000 TPD.

Exhibit 2.1 MSW processing methods - % of total



[5] As per Swachhtam portal of MoHUA, forecast of Central Public Health and Environmental Engineering Organization (CPHEEO) norms
[6] Swachh Bharat Mission - SBM Urban
[7] As per Swachhtam Portal of MoHUA

Bioremediation of legacy waste has also seen progress in the last few years, with over 3,000 acres of land recovered so far after remediating over 4.5 million tonnes of legacy MSW.

2.3 Imperatives going forward

The share of non-composting-based processing approaches will need to increase significantly and rapidly. This is particularly crucial given the relatively higher land footprint required for composting and the sharp rise in the share of non-biodegradable waste. ULBs will therefore need to explore alternatives to composting and proactively adopt other MSW processing solutions. Accelerating bioremediation of legacy waste is also essential.

The GoI acknowledges that a variety of waste processing approaches and recycling technologies will be necessary to address the challenges of MSW management. It also recognizes the need to raise awareness, build capacities, and develop expertise in different waste processing options and their implementation models.

As ULBs continue to expand processing capacity for MSW and remediate legacy dumpsites, they will need to build capacities to develop sustainable and bankable projects for these endeavors.

This section of the Reference Guide sheds light on business models for various MSW processing approaches and covers (i) progress and experience from adoption till date, (ii) typical scale, configuration, and costs, (iii) scope, implementation model, project structuring and bidding terms, (iv) financing, revenue streams and viability and (v) boundary conditions to tackle project risks (including social and environmental impacts) and enablers for success.

3

WASTE TO ELECTRICITY

3.1 Segment overview

Although thermal processing involves higher capital costs, technical sophistication, and greater preparatory rigor, it enables ULBs to manage waste with a significantly smaller land footprint. This makes it a suitable option for large, densely populated cities with limited land availability and higher levels of waste generation.

In thermal waste processing, the feedstock (which may be segregated waste, unsegregated waste, or Refuse-Derived Fuel [RDF] produced from waste) is thermally processed. Common approaches include:

- **Incineration** involving complete combustion of MSW (of calorific value higher than 1500 kcal) or of RDF with recovery of heat, to produce steam, which in turn produces power through steam turbines.
- **Pyrolysis** where heat is used to break down organic materials anaerobically into combustible gases (primarily Methane, complex hydrocarbons, Hydrogen, and Carbon Monoxide), and other liquid & solid residues.
- **Gasification** in which organic or fossil-based materials are converted into Carbon Monoxide, Hydrogen and Carbon Dioxide at elevated temperatures (500-1800^{0}C) in presence of limited amount of Oxygen, typically called as Syngas at above 900^{0}C along with conventional fuels like coal for generating heat.
- **Plasma Arc:** Plasma Arc Waste to Electricity (PAWTE) is a technology that converts solid waste into synthetic gas (Syngas) and vitrified slag using high-temperature (more than 2000^{0}C) plasma. Syngas can be used to generate electricity or produce fuels, while slag can be used as a construction material or can be landfilled.

Of these, **incineration based WtE projects have been most prevalent in India** and hence will be the focus of this section.

India's first Waste to Electricity (WtE) plant was established in Timarpur, Delhi, in 1987, using technology provided by Denmark. However, the plant failed due to various challenges, including wide variations in input waste characteristics, low calorific value of the waste for incineration, and a higher proportion of inert waste. Incineration-based processing requires waste with a high calorific value and a low percentage of inert waste. To achieve this, waste can be segregated, and the portion with a higher calorific value can be subjected to incineration.

For over a decade, attempts to deploy WtE technologies at scale remained unsuccessful due to their incompatibility with the characteristics of MSW prevalent in Indian cities. The Department of Science and Technology (DST), Government of India, then recommended converting the combustible fraction of MSW into Refused Derived Fuel (RDF) instead of directly feeding waste into boilers, ushering in a new era of WtE plants in India. Currently, India's Solid Waste Management (SWM) Rules 2016 prohibit mass burning of waste and require WtE plants to operate with either RDF or segregated/pre-processed mixed waste with a calorific value exceeding 1500 Kcal/kg.

Given that most of the available feedstock for WtE continues to be mixed waste with calorific values below 1500 Kcal/kg, pre-processing, sorting, and enhancing the quality of the waste feed become crucial for WtE plants to operate effectively. These methods include:

i. Storing, blending, and preparing mixed waste in pits for 10-15 days
ii. Using sorting and segregation equipment such as trommels, ballistic separators, shredders, and dryers

These methods have helped reduce moisture content, increase homogeneity, and improve the calorific value of waste, making WtE plants more operable.

The first successful operational WtE plant was commissioned in Okhla in September 2012. Since then, several other WtE plants have followed and become operational, including in Ghazipur (2015), Jabalpur (2016) and Narela Bawana (2017).

A 2014 task force appointed by GoI had assessed the untapped potential of WtE for MSW processing in India and projected a potential power generation of **439 MW** by processing an estimated **~ 32,890 TPD** of waste from WtE projects in the immediate term (5-7 years. Further, the task force report recommended that cities with a population of 2 million and above and generating more than **1,100 TPD of MSW** were suited for setting up standalone WtE plants and cities with a population of **1-2 million** and generating over **500 TPD** could

operate cluster based WtE plants and complement the same with RDF from nearby cities as input waste. The notable advantages of WtE noted in this report included the following:

- **Waste minimization** i.e., achieving the highest reduction in waste volume compared to other technologies
- **Lower land requirement** compared to other processing technologies
- **Productive energy recovery** and potentially **viable business models** through the sale of fuel and electricity

Since then, the adoption of WtE has indeed gathered pace. At present, there are **11** operational WtE plants with an estimated design capacity to process **~14,200 TPD** waste and generate **~160 MW** of electrical power. Further, more than 10 projects with a design capacity to process **9,700 TPD** waste and generate **130-140 MW** are under implementation[8]. WtE processing also significantly reduces the waste being disposed of at landfill sites. Thus, WtE is emerging as a practically feasible and implementable solution in the Indian context.

The following sections of this chapter discuss key contours of business models for setting up WtE facilities.

3.2 Scale, configuration, and project cost

In India, most WtE processing plants are based on incineration, where direct combustion of RDF or segregated/pre-processed mixed waste with a calorific value exceeding 1500 Kcal/kg is used to produce steam, which is then used to generate electricity. As discussed earlier, WtE plants are generally suitable and viable at larger scales, making them appropriate for million-plus cities. Key findings from operational WtE plants in India regarding scale and configuration are summarized below:

- **The ideal city profile conducive for WtE plants is that of cities with a population of more than a million that can earmark at least 500 TPD of MSW on a dedicated basis for such facilities**. Of the 6 projects reviewed under this exercise, all are more than 500 TPD capacity/7 MW of power generation. However, the Sonipat (750 TPD/ 8 MW) project was developed in a cluster mode covering 4 ULBs (Sonipat, Panipat, Samalkha, and Gannaur) to fulfill the standard criteria of 500 TPD to achieve operational and financial viability.
- Power generation varies between **1-1.5 MW per 100 ton** of waste handled. The range is wide given that the level of energy generation is impacted by multiple factors including technology, waste characteristics and pretreatment/ segregation.
- A key benefit of WtE plants is their low land footprint. A 500 TPD WtE plant (including pre-processing) requires **~ 5 acre/500 TPD** waste (including pre-processing unit) vis-à-vis **~ 5 acres/100 TPD** waste required for composting plants of similar size.
- Project cost of operational projects is in the range of **Rs. 15 – 25 Cr per MW** and **Rs. 23 – 29 Cr per 100 TPD capacity** excluding cost of land. Given that there is a wide array of technologies and configurations to pre-treat waste, there is a wide variation in the project costs across various projects. The higher cost/ MW for WtE projects is also attributable to integration of other processing techniques like composting and Sanitary Land Fill (SLF), e.g., at Narela-Bawana, Hyderabad and Sonipat.
- Most WtE facilities have been designed by ULBs to handle mixed waste and therefore need **segregation, storing, blending and homogenization for RDF manufacturing,** combustion, and an energy generation unit. This is a critical requirement that ULBs will need to keep in mind while earmarking land parcels for WtE facilities. It would also be pertinent to plan for a Sanitary Landfill (either integrated or separately managed) and earmark land for the same adjoining the WtE facility or nearby.
- WtE projects have typically been bid to achieve **a target Project IRR @ 12-15% and Equity IRR @ 14- 18%.** However, it may be noted that the IRR expectations vary depending on project-level factors (counterparty capacity and financial strength, project risks and structuring) as well as macro factors (interest rates, economic outlook etc.)

[8] Sbmurban.org

- Refer to exhibit 3.1 for salient aspects of select operational WtE projects from select Indian cities with respect to the above parameters. The trends discussed above are also largely reflected in projects under implementation.

Exhibit 3.1 Salient features of select operational WtE projects

Parameter	Jabalpur	Sonipat	Hyderabad	Tehkhand
Technology type	Mass Incineration	Integrated Project including Collection and Transportation (C&T) (RDF based Incineration)	Integrated project including secondary transportation RDF based Incineration	RDF based Incineration
Waste type	Mixed	Mixed	Mixed	Mixed
Waste processed (TPD)	600	750	6000	2000
Power generated (MW)	11.5	8	24	25
Land Available (Acres)	**10**	**39***	**14**	**15**
Project cost (Rs Crore)	178	200	468	460
Power generation (MW/100 TPD)	1.9	1	2	1.25
Project cost (Rs. cr. / MW)	~15.5	~25	19.5	~18.5
Project cost (Rs. cr. /100 TPD)	29.6	26.6	39	23

Source: Primary & Secondary research and discussion with private operators. Project cost may vary for similar designed capacity WtE projects based on technology, scope, availability of water, suitability of land (soil strength), cost of power evacuation, and emission standards. *Includes 19 Acres for WtE + 20 Acres for SLF)

3.3 Scope, Implementation mode, project structuring and bid variable

Most operational WtE projects in Indian cities have been set up on Public-Private Partnership (PPP) mode, where the developer is typically selected by the ULB through a competitive bidding process. Key findings from operational projects on PPP implementation mode are summarized below.

- WtE projects have been structured with either **Integrated** or **Processing-only** as scope.
  - In **Integrated** WtE projects at Narela-Bawana, Hyderabad, and Sonipat, the developer's scope covers waste collection & transportation, processing, and disposal of inert rejects in a sanitary landfill. Here, the selected developer is responsible for waste collection and transportation within an earmarked area (either covering the whole city or part of the city) apart from being responsible for setting up the processing and SLF.
  - In **Processing-only** WtE projects, the developer is not responsible for collection and transportation but only for handling and managing waste at the WtE facility. The ULB/authority is responsible for delivering a pre-committed quantity and quality of waste to the operator's facility. In many cases, a tipping fee is provided by the ULB to the developer per tonne of waste delivered. (A tipping fee is paid by entities that dispose of waste at a processing facility or landfill.) For example, in WtE projects at Okhla, Ghazipur, Pimpri Chinchwad, Jabalpur, and Tehkhand, the WtE developer is responsible only for waste processing and ensuring that residual waste sent to the landfill does not exceed the target cap (typically 20%) set in the Concession Agreement. Landfill operation is not within the scope of the developer in these specific projects.
  - *Integrated WtE projects are typically conceptualized in cities where (i) waste generation is more than 500 TPD, (ii) waste collection / segregation practices are weak and (iii) pre-processing is needed to separate wet and dry waste. Preferred bid variable in integrated projects is Output based incentives (OBI)/ tipping fee/processing fee/tariff or combination of any of the two. In a processing only WtE PPP, the ULB takes the responsibility for providing a pre-specified quantity and quality of waste. The Preferred bid variable in processing projects is Output based incentives (OBI)/processing fee/tariff or combination of any of the two. In processing only there will not be any tipping fees. The choice between integrated or processing only projects therefore is contingent on the ULB's waste segregation, collection, and transport infrastructure.*

- Most WtE projects have been bid competitively on **PPP mode** by respective ULBs or the competent authorities. Although a variety of PPP formats are acceptable, **WtE projects have been largely bid on a Design Build, Finance, Operate, Transfer (DBFOT) or Design, Build, Finance, Operate (DBFO) format**. WtE concessions are upwards of **20 years**, in line with the life of WtE plants (at over 25 years) with the selected developer typically setting up a special purpose vehicle (SPV) to execute the project.
- Given that WtE projects are technology-intensive, a private developer with strong sectoral credentials and relevant prior experience is required to manage the technology, construction, and operational risks. In most WtE projects, the private developer's performance is monitored and measured through a performance monitoring mechanism and is linked to compensation. Accordingly, incentives may be paid or penalties levied. For instance, most WtE projects require: (i) a specific timeframe for completion of construction, (ii) emission standards in line with standards by Central Pollution Control Board/ or as provided for in the Concession Agreement, (iii) Plant availability, and (iv) a cap on the residual waste sent to landfill.
- Given that WtE are both capital-intensive and operationally demanding, the commercial viability of projects require additional financial support. This has been typically provided either through **Viability Gap Funding** (as a government grant to reduce return-earning capex burden) or building **revenue certainty** through a processing/tipping fee payable per tonne of waste processed, in addition to the revenue from energy generation.

Bid variable in WtE projects: A variety of approaches are in vogue

WtE projects can be structured to be bid out using a variety of bid variables as seen in the Indian context. While tariff-based bidding is the most common, other approaches have also been adopted. Various bid variables are as follows-

1. **Tariff-based bidding:** Tariff (quoted as Rs/kilowatt hour [KWH]) is the price at which power is generated by the WtE. In this type of bid, other terms such as power generation and waste handling capacity, viability gap funding (VGF) available or tipping fee/processing fee payable are fixed and known in advance. The developer quoting the lowest tariff for selling power is selected and enters into a power purchase agreement (PPA) with the respective electricity distribution company (DISCOM). The Tehkhand WtE project in Delhi has been bid on this model without providing for a tipping fee. The State/ULB helps the developer in obtaining the approval of draft PPA and facilitates in obtaining the approval of levelized tariff for the project, along with the signing of PPA with DISCOM/ State Electricity Regulatory Commission (SERC).
2. **Processing/Tipping fee:** Tipping fee, quoted by the developer, as rupees/ton of waste received at WtE plant. Jabalpur and Bawana WtE projects have been bid based on processing/tipping fees as the bid variables and in addition to this, the developer gets its revenue from sale of power as well.
3. **Viability Gap funding (VGF):** Also known as grant-based bidding, the bidder quoting the least viability gap grant payable by the authority, is selected as the preferred bidder. Patna is developing a WtE project with VGF as a bid variable with revenue from sale of power being available to the project developer.
4. **Output-Based Incentive (OBI):** In OBI, the bidders are required to quote a composite OBI payable per KWH generated. The OBI is typically higher than the tariff approved by the electricity regulatory commission for power sale. The revenue is computed based on the approved tariff to be paid by the DISCOM to whom power is sold while the balance of the difference of OBI-tariff is paid by ULB. The ULB component of OBI is indexed to inflation. This approach links ULB payouts to actual energy generation and incentivizes the developer to maximize power generation. The WtE project in the Sonipat cluster is being bid on this format and reduces uncertainty on part of developer with respect to tariff determination by the regulator as the differential is underwritten and paid for by the ULB. The tariff is levelized for 20 years and it does not fluctuate. The advantage of OBI is that the developer gets its revenue from sale of power over and above the levelized tariff to meet the expenses and make the projects sustainable over long run. For clarification, the tariff cannot be higher than OBI as Central Electricity Regulatory Commission (CERC) regulated tariff is disclosed to the bidder during tendering stage and in case it is higher, then the ULB need not to pay anything to the developer, who will generate its revenue solely from the sale of power to DISCOMs.

OBI thus makes up for expenses incurred on producing power, the cost of collection, transportation, and profit margins. However, in tariff-based bidding only the cost of production of power and profit margins are covered.

Tariff-based bidding works well if there is regulatory clarity and the DISCOMs are willing to support the arrangement. OBI model helps insulate tariff risks for an operator by having the ULB pay for the differential. Where VGF is being provided, it is required to be competitively discovered under PPP policy, and hence becomes the de facto bid variable. Bidding variable therefore needs to be contextually appropriate and needs to be finalized considering project and ULB specific factors at the time of project preparation.

ULB Offtake for WtE – Case of Pimpri-Chinchwad Municipal Corporation

Given the dependency on sale of power, WtE projects are subject to the vagaries of approval of tariff by electricity regulatory commission, as well as payment / counterparty risk arising from electricity DISCOM, with whom a PPA is signed. In an interesting variant, the Pimpri-Chinchwad Municipal Corporation (PCMC) tendered their WtE project on tipping fee / processing fee as bid variable while offering committed VGF and offtake of power at a pre-set tariff (~INR 5 /KWH) for its own consumption. This way it delinked the WtE project from having to deal with multiple entities (ULB, DISCOM and Electricity Regulatory Commission) and saved time and risk in tariff determination and obtaining approvals.

Refer to *Exhibit* 3.2 for a snapshot of scope, implementation mode and bid variable in select WtE projects.

Exhibit 3.2 WtE – scope, implementation mode and bid variable – select operational projects

Parameter	Tehkhand	Sonipat	Jabalpur	Hyderabad
Project scope	Processing, Disposal	Collection, Transportation, Processing & Disposal	Processing, Disposal	Integrated - secondary transportation, pre-processing, disposal
Implementation mode	PPP-DBFOT	PPP-DBFOT	PPP-DBFOT	PPP-DBFOT
Capacity (Waste TPD)	2000	750	600	6000 (Mixed waste) & 1200 RDF is recov
Concession period	25 years	22 years	20 years	25 years
Duration operational	1 year	2 years	7 years	3 years
Bid variable	Tariff	OBI	Processing Fee*	Tipping Fee + Levelized Tariff at Rs 7.84 per unit
PPA Tariff (per KWH)	Rs. 5.13 (Levelized)	Rs. 6.84	Rs. 6.39	Rs.7.84
Tariff escalation % YoY	Levelized	Levelized	Levelized	Levelized
Processing / Tipping fee	No tipping fees	OBI Rs. 3.44 / KWH power Rs. 333 per tonne (4% YoY escalation)	Not available	Rs. 1,400 Per tonne
Land Lease cost	Yr. 1-12: Rs. 25 Lakh/acre Yr. 13-25: Rs. 30 Lakh/acre	Rs. 4000 per acre per annum	Not available	Not available
Royalty Paid by Operator	(No Royalty being paid)	(No Royalty being paid)	~ Rs. 20.7 per tonne	(No Royalty being paid)
Cost for Disposal of Inert	~Rs 350 per tonne	Covered in the project cost	Not Applicable	Rs 350 to 400 per tonne

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

3.4 Financing mix, revenue streams and commercial viability

WtE projects involve high upfront capital costs and typically face a significant degree of uncertainty regarding revenue realization from the power generated and supplied. This is due to the need to enter into a Power Purchase Agreement (PPA) with another counterparty, such as a Distribution System Operator (DISCOM), and the necessity of obtaining tariff approval from the electricity regulatory commission.

Developing and structuring a bankable WtE project will therefore require both a scrutiny of choices available to the ULB coupled with early engagement with the electricity DISCOM and electricity regulator upfront during project preparation. From a financial standpoint, the project's financial viability is driven by three variables. First the availability of **Viability Gap Funding** can help reduce the requirement for recovering project costs via earnings (which is to be raised by the developer in the form of equity and debt). Second, revenue realizable from **sale of power** generated from the waste processed. Third, **additional revenue streams** viz., tipping / processing fee available to the project. Together, these three levers are used in varying degrees to address project's financial viability.

- **Viability Gap Funding (VGF) grants:** VGF grants are a valuable tool for addressing the bankability and viability of WtE projects. Several WtE projects, including Tehkhand, Sonipat, and Jabalpur, have received VGF to varying degrees. While Tehkhand was awarded a VGF of Rs. 105 crores (or 23% of the project cost), Sonipat and Okhla received 19.8% and 2.9% of the project cost as VGF, respectively. The availability of VGF provides a useful risk mitigation mechanism and is often seen as an indicator of the concessioning authority's and government's commitment to the project.
- **Revenue from sale of power:** One of the primary revenue sources for WtE projects is the sale of electricity to DISCOMs. The generated electricity can be sold to utilities under Power Purchase Agreements (PPAs) or to the ULB as a captive user, generating revenue based on the electricity exported to the grid. The level of tariff available, along with the assurance and certainty of realizing this revenue stream, is crucial for WtE projects. A review of operational projects in India reveals that the tariff for WtE projects has ranged between Rs. 5 per KWH to Rs. 7.84 per KWH. The variation reflects the diversity of projects in terms of not only technology and waste characteristics but also structuring aspects, including the availability of VGF and the magnitude of other revenue streams such as processing/tipping fees. The regulatory commission considers these factors when fixing or approving the tariff for the sale of power.
- **Revenue from processing fee/tipping fee:** Many WtE projects have sought to provide processing fee/ tipping fee to augment the revenue streams available to WtE projects. The tipping fee tends to be a large component in projects where the scope includes only collection and transportation. For instance, in Narela-Bawana, Delhi where collection and transportation are part of the scope, the tipping fee is Rs. 1950/tonne while in Pimpri Chinchwad where the scope covers only processing, the tipping fee is Rs. 500/ tonne. This fee is typically paid out of the ULB's general budget.
- **Other revenue streams**: WtE projects also typically have by-products. For instance, ash or residues generated from combustion have potential uses in construction materials, road construction, or as an additive in cement production. Bricks made from ash can be sold in the market. WtE projects that reduce greenhouse gas emissions are eligible for carbon credits through Clean Development Mechanism (CDM) modality. Further, WtE projects can also earn Renewable Energy Certificates (RECs), which can be sold to entities seeking to meet renewable energy targets or sustainability goals. Some projects like Timarpur Okhla have earned carbon credits.
- In case of processing only models, the entire cost will be on the tariff while in the case of integrated projects the other component of waste management like C&T and disposal are attributable to tipping fees which varies depending upon the projects. Nevertheless, the majority share of the revenue for WtE plants (upwards of 95%) for project developers for projects executed on PPP mode is from processing/ tipping fee and the sale of power. Refer to *Exhibit 6.2* for a snapshot of the financing mix and revenue streams in select operational WtE projects.

Exhibit 3.3 WtE – financing mix, and revenue streams – select operational projects

Parameter	Tehkand	Sonipat	Jabalpur	Okhla	Narela Bawana
Capacity (TPD)	2,000	750	600	1,950	1,200
Project Cost (Rs. cr.)	460	200	178	345	544
Financing mix					
VGF (Rs. cr.) (% of project cost)	105 Cr. (23%)	39.6 Cr. (19.8%)	No VGF	10 Cr. (2.9%)	No VGF
Private (Rs. cr.) (% of project cost)	355 (73%)	160.4 (80.2%)	544 (100%)	335 Cr. (97%)	544 (100%)
Revenue drivers					
Sale of Power (Rs./KWH)	5.13*	6.84*	6.39*	See note**	7.03*
Tipping/Processing fee (Rs./ton)	No tipping fee	333***	Not available	No tipping fee	1950
Sale of by-products (Rs./ton)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Rs. 0.50 Cr
Reported revenue Rs. cr. (Fin. year)	**Rs. 85 Cr**	**Rs. 60 Cr**	**Rs. 23 Cr**	**Rs. 60 Cr**	**Rs. 95 Cr**

Source: Secondary research, KPMG analysis. * Levelized Tariff. ** BSES Rajdhani Power Limited (BRPL) (60 MUs): Rs. 2.49 PU with 2% escalation for 1-10 Years, & 1% for 11-25 Years; TPDDL (6 MW – Long Term Open Access (LTOA)) and Rs. 5.83 PU (Levelized). ***A differential OBI amount of 3.44/ KWH of power generated is further payable

Given the scale and complexity of WtE projects, ULBs will need to devote significant attention to structuring projects in a manner that comprehensively addresses financing risks and ensures a high degree of revenue assurance and visibility. Early-stage consultations with a wide range of stakeholders, including DISCOMs and regulators, as well as market sounding conversations with investors and debt providers, should be a key input into project structuring to build assurance and certainty throughout the bidding process. The following section summarizes critical structuring considerations and boundary conditions for the successful preparation, rollout, and implementation of WtE projects.

3.5 Boundary conditions and enablers for success

Critical considerations for preparing and structuring bankable WtE projects are summarized below:

1. Minimum size threshold, assured waste availability

The WtE projects that are operational validate the observations made by GoI Taskforce on the need for a threshold scale for WtE projects for them to be financially and operationally viable. An input waste quantity of 500 TPD & above seems to emerge as a threshold minimum. Million-plus cities or clusters of urban areas with a population of 1 million and above appear to be potential candidate cities/regions for WtE projects. The ULB or the urban region should guarantee the waste supplies for the project to succeed. Variations in waste composition, including moisture content, calorific value, and contaminants can affect the efficiency and performance of the waste conversion processes.

Most operating plants appear to have managed to receive and process the threshold amount of waste and have developed the ability to make the waste suitable (the required quality) to sustain the operations. *Among recent projects, Jabalpur has commissioned a WtE project with a design capacity of 600 TPD, but the sub-par performance with respect to waste availability (estimated at less than 400 TPD) has had an impact on operational and financial viability of the project.*

2. Land availability and landfill infrastructure

As with any waste processing project, the availability of encumbrance-free land (with title to land or leasehold rights) that meets requisite infrastructure requirements and adheres to permissible limits (imposed by authorities regarding habitation, water bodies, airports, etc.) for the entire project lifecycle is a vital prerequisite for WtE projects. If the operator's scope includes handling residual waste, land required for setting up and managing such facilities, including a processing facility for ash and a disposal facility like a landfill, should also be earmarked and provided upfront.

Land requirement for WtE projects is to be considered at approximately 1 acre for managing 100 TPD of waste. Up to 10 MW/1000 TPD, the land requirement can be estimated at 1 acre/100 TPD. Beyond 10 acres or 1000 TPD, the land requirement will be lesser than the thumb rule suggested.

Land availability has been a challenge even in projects that are operational. Tehkhand project of 2000 TPD was conceived on 15 acres with an annual lease rental of 25 lakh/acre for the first 12 years. Although it doesn't strictly meet the 1 acre / 100 TPD norm, land availability is expected to be sufficient given economies of scale. In Ghazipur, a 1300 TPD plant has been conceptualized with a highly constrained 5.7-acre land (with annual lease rent of Rs. 4080 per acre. This translates to higher cost of civil works relative to peers owing to higher automation for waste handling efficiency)

3. Environment & Social impacts, safeguards, and compliance to standards

WtE projects with Sanitary Landfills require Environment Clearance (EC) and other approvals from regulatory authorities at the local, regional, and national levels. Social impact is covered under the final report of EC of the project. The approvals are time-consuming and delays in securing this can be overcome through ULB/ State support. ULBs are required to comply with standards for air emissions and discharge quality standards for wastewater against CPCB/ international norms.

Prior to June 2017, EC was required for all WtE plants and took at least 1-2 years. This condition has now been relaxed as EC is only required if the project capacity is more than 25 MW or if it is developed along with an SLF. This differential requirement, while somewhat favorable for standalone WtE projects, creates a risk of ULBs opting to prepare and develop WtE projects without adequately planning for required sanitary landfill capacities.

Managing and controlling emissions to requisite standards is impacted by the variation in the characteristics of waste received. The developer who typically takes this risk will need to put in place a design and system that can deal with a wide range of variation in waste quality and characteristics. Deployment of flue-gas treatment system and continuous emission monitoring system (CEMS) to achieve emission norms meeting national standards (that are progressively aligned with global best practices) ought to be a mandatory requirement.

WtE projects often face opposition from local communities due to concerns about health and environmental risks. Public acceptance is crucial for the successful implementation of WtE projects, and community engagement, education, and transparency are essential to address concerns, build trust, and gain support from stakeholders.

4. Preparatory rigor and Government commitments for bankability

WtE projects require substantial upfront capital investment and given a history of project failures, and uncertainty around revenue streams, lenders continue to look at WtE projects as high-risk projects. Therefore, signaling strong government commitment (through VGF in case of low financial viability and through other such measures) and assurance becomes central to the bankability of the projects.

Apart from land and infrastructure availability, a clear commitment to waste availability and assurance of support for obtaining necessary approvals (especially for environmental clearance and related matters), along with timely payment assurance, is crucial for project bankability.

A draft Power Purchase Agreement (PPA) outlining the terms and conditions of the electricity sale, including price, contract duration, delivery terms, and payment terms, should be provided as part of the bid documents after reaching an agreement with the DISCOM. Signing a PPA should be preceded by the timely completion of feasibility studies, technology selection, engineering design, environmental assessments, and securing necessary permits and approvals. The following three aspects can significantly contribute to the success or failure of a project:

- **Availability of Viability Gap funding:** Availability of Viability Gap funds for WtE projects help in the reduction in effective return-earning capital requirement (equity and debt) and are a direct means to improve project viability. This also signals a strong government commitment to the project from an investor's perspective. Tehkhand and Sonipat projects had ~23% of project cost coming in the form of VGF contributing to project bankability.
- **Revenue assurance:** Power purchase agreements (either with DISCOMs or ULBs) will need to be backed with clarity on tariff certainty, as well as process and timelines for regulatory approval. Wherever feasible, offtake commitment of power produced makes contracting structure more seamless. In recent projects like in PCMC, ULBs (instead of DISCOMs) have stepped forward to provide offtake commitments and tariff certainty, which is a positive development with potential for replication. . In the Tehkhand WtE project, the PPA signing, and tariff determination were completed without delays and aided the seamless construction and commissioning of the project.
- **Payment security from ULBs:** Use of escrow structures where some visible revenue streams (such as property taxes) is ring-fenced for payment of processing/ tipping fee can help provide payment assurance to the developers. Most operational projects have been provided with some form of payment security.

5. Accountability – linking compensation, incentives, and penalties to performance

Finally, effective operational outcomes are contingent on practical yet effective linkages of compensation incentives and penalties to performance and adherence to contractual obligations by all parties.

- On the developer's side, concession agreements will need to have specific targets, including for (i) timelines for project commissioning, (ii) cap on residue and inert waste sent to landfill, and (iii) meeting air emission and water/ wastewater discharge standards as per concession agreement (CA).
- Similarly, ULB's obligations include (i) supply of committed waste quantity and quality (ii) provision of committed land and infrastructure availability, and (iii) meeting the financing covenants including viability gap funds, revenue assurance and payment security.

3.6 Case Study: Sonipat Cluster Model

3.6.1. Background

The Sonipat WtE project is a cluster-based integrated waste management project covering four ULBs in Haryana namely- Sonipat, Panipat, Samalkha, and Gannaur. Waste generation in these four ULBs is estimated at 700-750 TPD. Since Sonipat's own waste generation was only 300-350 TPD and below the threshold of 500 TPD required for a viable WtE project, adjoining cities within a 50 km radius were clustered to provide adequate waste to the WtE project.

Conceptualized in 2017 and bid on a PPP-DBFOT format with a 20-year concession period, the Sonipat WtE project was awarded in August 2019 and commissioned in August 2021. The plant is operational at present at its designed capacity of 700-750 TPD and 7-8 MW.

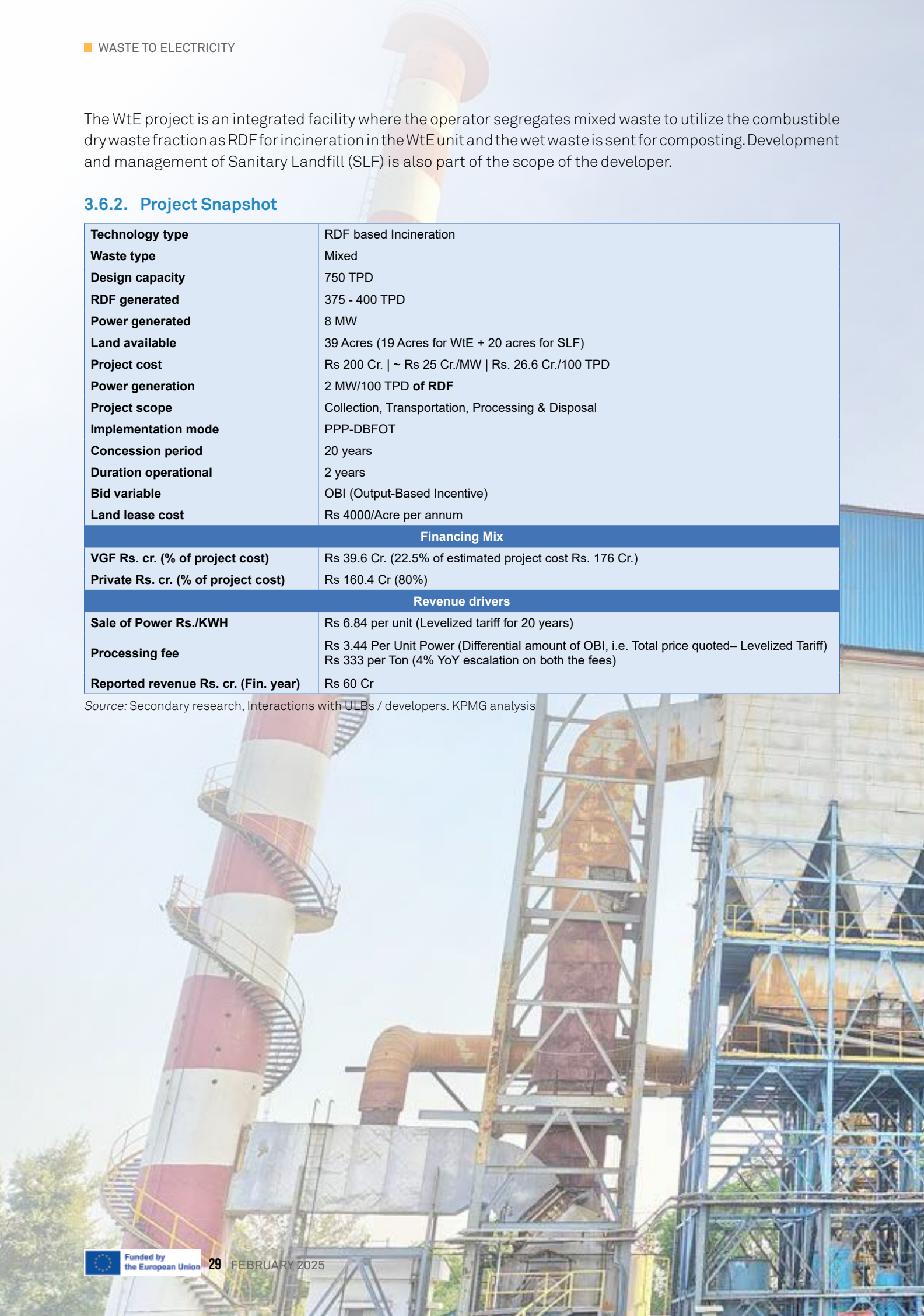
M/s JBM Environment Management Private Limited emerged as the winning bidder and it developed and is operating the facility. The bid variable for the project was OBI payable on the KWH (units of power) generated. The project scope includes waste collection and transportation from all four ULBs (including setting up, and operating transfer stations enroute) to the WtE plant located in Murthal, Sonipat.

The WtE project is an integrated facility where the operator segregates mixed waste to utilize the combustible dry waste fraction as RDF for incineration in the WtE unit and the wet waste is sent for composting. Development and management of Sanitary Landfill (SLF) is also part of the scope of the developer.

3.6.2. Project Snapshot

Technology type	RDF based Incineration
Waste type	Mixed
Design capacity	750 TPD
RDF generated	375 - 400 TPD
Power generated	8 MW
Land available	39 Acres (19 Acres for WtE + 20 acres for SLF)
Project cost	Rs 200 Cr. | ~ Rs 25 Cr./MW | Rs. 26.6 Cr./100 TPD
Power generation	2 MW/100 TPD **of RDF**
Project scope	Collection, Transportation, Processing & Disposal
Implementation mode	PPP-DBFOT
Concession period	20 years
Duration operational	2 years
Bid variable	OBI (Output-Based Incentive)
Land lease cost	Rs 4000/Acre per annum
Financing Mix	
VGF Rs. cr. (% of project cost)	Rs 39.6 Cr. (22.5% of estimated project cost Rs. 176 Cr.)
Private Rs. cr. (% of project cost)	Rs 160.4 Cr (80%)
Revenue drivers	
Sale of Power Rs./KWH	Rs 6.84 per unit (Levelized tariff for 20 years)
Processing fee	Rs 3.44 Per Unit Power (Differential amount of OBI, i.e. Total price quoted– Levelized Tariff) Rs 333 per Ton (4% YoY escalation on both the fees)
Reported revenue Rs. cr. (Fin. year)	Rs 60 Cr

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis



3.6.3. Replicable project features

- **Rigor in project preparation:** The project was conceptualized by the State Urban Development Department of Haryana and supported by a robust Technical Feasibility Report. This report included a thorough study of the project area (ULB cluster), analyzing waste generation and projection patterns for the 20-year project design period, fluctuations in waste characteristics and related factors, project infrastructure requirements (including the number of C&T vehicles needed, Transfer Stations), and overall indicative costing.
- **Land availability:** Encumbrance-free land was identified prior to the project was bid and EC for the project was also initiated by the Department of ULBs.

- **Balanced risk-sharing and payment security:** To ensure balance risk sharing between ULB and Developer levelized tariff was identified and disclosed to bidder prior to bid submission and approval of the draft PPA was also taken from Haryana Electricity Regulatory Commission (HERC) prior to bid submission. An Escrow account was opened for payment to Developer with the provision to maintain 3 months of advance operating cost in the escrow to cater for any delay in payment by ULB.
- **State Government commitment and support to get multiple ULBs to collaborate and develop a cluster-based project:** The project was developed on PPP and an open tendering process was adopted for the project to ensure that all eligible parties participate. The bid documents were structured and vetted from a legal perspective and a Tripartite Agreement was signed by the Department of Urban Local Bodies, Haryana (as project administrator), ULBs and Developer. The Department of ULBs also facilitated an inter- ULB agreement between the participating ULBs stating the obligations of each ULB and allocating rights to the project developer on the waste collected in these ULBs. Without intervention by the state department, this project may not have been possible.
- **OBI as bid variable to maximize processing of waste:** The bid variable for the project was OBI per KWH generated. This links ULB payouts to actual energy generation and incentivizes the developer to maximize power generation and reduces uncertainty on part of the developer with respect to tariff determination by the Regulator as the differential is underwritten and paid for by the ULB.
- Cluster-based projects face common challenges, such as land availability and coordination between ULBs. In this project, Sonipat was the lead ULB, responsible for providing land, waste collection, and payment to the operator. Each ULB identified a nodal person to oversee the project's day-to-day operations. This model can be replicated in other areas in other States where individual ULBs may not generate enough waste (minimum 500 TPD) to support a Waste to Electricity (WtE) plant, but where land is available and ULBs are within 40-50 km of each other such that they can come together to make a sustainable project. The cluster model can help divert waste from landfills and thus save land.

4

BIO-METHANATION

4.1. Segment overview

Biodegradable waste comprises over half of the Municipal Solid Waste (MSW) generated in India. Despite efforts to expand processing capacities for biodegradable waste (primarily through composting), a significant portion of this biodegradable waste is handled as mixed waste and consequently dumped indiscriminately at dumpsites across the country without adequate processing. This not only poses significant public health risks but also contributes to the release of methane from the decomposition of such dumped organic and biodegradable waste. Methane is a major contributor to greenhouse gas (GHG) emissions and global warming. India ranks among the top three countries globally in terms of absolute GHG emissions from landfills and waste dumpsites9.

Bio-methanation is a reliable and promising process to address this challenge and is particularly well-suited for India. Its adaptability to various scales, as demonstrated in multiple projects in India, makes it suitable for diverse levels of waste generation across different tiers of Indian cities and towns. Bio-methanation offers dual benefits by addressing biodegradable waste and converting it into biogas, which can potentially replace and reduce the overall use of fossil fuels. Compared to other modern waste management technologies, **bio-methanation is a well understood technology, capital intensive, relatively economical, eco- friendly and moderately labor intensive.**

India has a long history of using bio-methanation dating back to the 1930s, primarily for sewage treatment. The use of bio-methanation in MSW processing gained significant momentum when the Government of India's National Master Plan for waste management, formulated in 1994, incorporated bio-methanation as a key Waste to Electricity option to be developed and adopted on a large scale.

Although there are several research studies and homegrown technologies available, the progress in setting up large bio-methanation plants (of sizes of 100 TPD and more) to produce compressed biogas (CBG) from MSW has been slow, despite vast potential.

Furthermore, even though several research studies were conducted proving efficacy of bio-methanation, the process is still unpopular especially for large scale projects i.e., more than 100 TPD. It may be noted that only 74 bio-methanation projects having designed capacity more than 50 TPD are in operation due to poor source segregation, inadequate knowledge on treatment systems and due consideration by the state governments and ULBs.

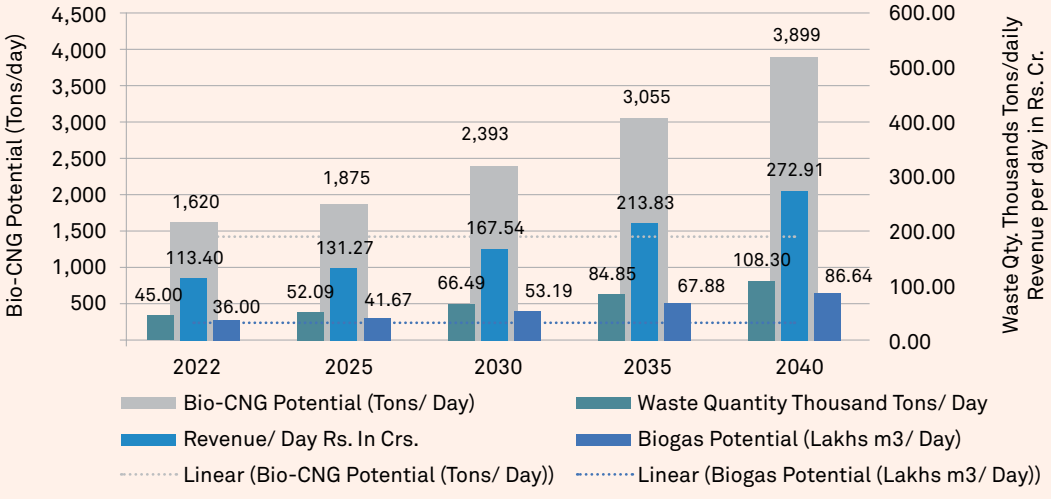
[9] India: CO2 Country Profile - Our World in Data

The Government of India recognizes the criticality of scaling up CBG and introduced the Sustainable Alternative Towards Affordable Transportation (SATAT) scheme which envisages production of 15 MMT (million metric tons) of CBG, from over 5000 Plants, using inputs like press mud, agri-waste, sewage and MSW. Under this scheme, entrepreneurs can set up CBG plants to produce and supply CBG to public sector Oil Marketing Companies (OMCs). The primary objectives of SATAT scheme are as follows:

- Reduce import dependence of India for meeting its energy needs
- Fulfill domestic energy requirements in a sustainable and eco-friendly manner, and reduce GHG emissions
- Better utilization of agri-residue, cattle dung, and MSW, thereby helping in tackling problem of air pollution
- Boost entrepreneurship, economy, and employment

Refer to Exhibit 4.1 for a trajectory of potential waste processing and CBG production:

Exhibit 4.1 Bio CNG potential from MSW



Source: Circular Economy in Solid & Liquid Waste. MoHUA, 2021

4.2. Scale, configuration, and project cost

Bio-methanation involves anaerobic digestion of biodegradable organic waste in an enclosed space under controlled conditions of temperature, moisture, pH, etc. It is an engineered decomposing system wherein depending on waste characteristics, waste mass undergoes decomposition anaerobically thereby generating biogas, comprising mainly of methane and carbon dioxide. The reduced organic and inorganic compounds produced by anaerobic microbial processes serve as carbon and energy.

The characteristics of available feedstock and the amount of segregated waste available are key determinants of the size of a biogas plant. Other factors for plant size determination include land availability, storage requirements of feedstock (agri and MSW), availability of utilities like water and electricity etc.

Findings from operational CBG plants in India with respect to scale and configuration are summarized below:

- Effective source segregation of waste determines efficacy of CBG plants. Cities with effective source segregation including Indore, Pune, Surat, and Chennai allow for well-functioning CBG plants.

- Bio-methanation plants of various sizes are functional. There are only 7 operational medium and large size bio-methanation projects in India with processing capacities ranging from **50 TPD to 550 TPD.** [10]
- Based on the type and characteristics of MSW feed, yields of CBG generation range across a wider spectrum of **30-35 kg of CBG** per ton of waste handled. The range is wide because the level of biogas generation is impacted by multiple factors including technology, waste characteristics and extent of contamination in the feed.

Bio-methanation plants have similar land footprint, relative to composting facilities. A 100 TPD WtE plant (including pre-processing) requires **~ 5-6 acre/100 TPD** waste including pre processing, maturing/processing of Fermented Organic Manure (FOM) & Liquid Fermented Organic Manure (LFOM) and to comply with Fertilizer Control Orders (FCO) norms and to comply with the Petroleum and explosive safety organization (PESO) Standards due to Explosive nature of the Bio-Gas.

- Project costs of operational projects range from **Rs. 30 – 35 Cr per 100 TPD of waste** (by comparison, WtE costs Rs. 23 – 29 Cr per 100 TPD of waste). However, given a wide array of technologies and configurations to pre-treat waste, there is a wide variation in the project costs across various projects (as seen in Exhibit 4.2).

Refer to *Exhibit 4.2* for salient aspects of select operational Bio-methanation projects from select Indian cities. The trends discussed above are also largely reflected in projects under implementation.

Exhibit 4.2 Bio-methanation – Salient features of select operational projects

Parameter	Indore	Solapur	Pune	Chennai	Surat
Technology type	Anaerobic Digestion (AD)	DRYAD™ technology	Anaerobic Digestion (AD)	Nisarguna, BARC	Modified M- Up-flow anaerobic sludge blanket (UASB) Digester
Waste type	Segregated	Segregated	Segregated	Segregated	Segregated
Designed Capacity (TPD)	550	400	300	100	50
Waste processed (TPD)	525-550	250	300	90-100	45-50
CBG yield / Power produced	32 Kg/ton	2 MW	45 Kg/ton	30 Kg/ton	40 Kg/ton
Land Available (Acres)	15.8	**9**	5	NA	NA
Project cost (Rs Cr.)	178	110	65	25	12
Project cost (Rs. Cr./100 TPD)	32.5	27.5	21.6	25	24

Source: Secondary research, KPMG analysis. Project cost may vary for similar designed capacity WtE projects based on technology, scope, availability of water, cost of CBG/power evacuation.

4.3. Scope, Implementation mode, project structuring and bid variable

Most operational bio-methanation projects in Indian cities have been set up on PPP mode, where the developer is typically selected by the ULB through a competitive bidding process or on nomination basis. Key findings from operational projects currently in implementation mode are summarized below:

- Bio-methanation projects have primarily been structured with a **processing-only scope**. Under this arrangement, projects are structured with processing and disposal/utilization of Fertilized Organic Manure (FOM) as the scope for the developer. The ULB/authority provides a commitment regarding the quantity and quality of waste that will be made available at the gate, and in most cases, the ULB will provide a tipping fee at the gate to the developer for processing waste. Alternatively, in other cases, the developer is mandated to pay a royalty to the ULB for providing source-segregated wet waste at the gate. The developer is obligated to fulfill only waste processing and ensure that FOM is utilized. Any processing rejects are sent to a landfill or as specified in the concession agreement.
- Most projects have been competitively bid on **PPP mode** by respective ULBs or competent authorities. Although a variety of PPP formats are in vogue, bio-methanation projects have been largely bid out on

a Design Build, Finance, Operate, Transfer (DBFOT) mode. EPC mode of project execution has also been prevalent particularly for smaller size projects. For instance, Indore has a smaller 15 TPD (designed capacity) bio-methanation project developed on EPC mode which got commissioned in 2018 but adopted a PPP structure for its larger bio-methanation project.

- Concession period for PPP projects is upwards of 20 years, in line with the life of plants being over 25 years, with the selected private developer typically setting up a special purpose vehicle (SPV).Given the technology-intensive nature of these projects, technology adoption, construction and operational risks are transferred to a private developer with the necessary credentials and experience to manage them effectively.

Bid variable in Bio-methanation projects:

1. **Highest Royalty to ULB:** Highest royalty per ton paid by the developer to ULB for providing source segregated wet waste at the project facility. Indore and Chennai projects have been bid on this model. (Royalty should not be kept as a bid variable and same has been revoked from the Model Tender Documents prepared by MoHUA).
2. **Processing/Tipping fee:** Tipping fee (quoted as Rs/ton) paid to the developer. Solapur and Pune projects have been bid based on processing/tipping fee.

   Processing fees is for projects where the ULB cannot provided source segregated waste to the Developer and a royalty may be charged by the ULBs for ensuring supply of source segregated wet waste.
3. **Viability Gap funding (VGF):** Also known as grant-based bidding, the bidder quoting the least viability gap grant payable during construction stage is selected as the preferred bidder. One small scale project of 20 TPD in Indore is developed with VGF as bid variable.

Exhibit 4.3 Bio-methanation – scope, implementation mode & bid variable – select operational projects

Parameter	Indore	Solapur	Pune	Chennai	Surat
Project scope	Processing & Disposal	Processing & Disposal	Processing & Disposal	Processing & Disposal	Processing & Disposal
Implementation mode	PPP-DBFOT	PPP-DBFOT	PPP-BOO	PPP-DBFOT	PPP-DBFOT
Capacity (TPD)	550	400	300	100	50
Concession period	20 Years	30 Years	20 Years	20 Years	20 Years
Operational Since	May 2022 (2 Years)	Jul-2013 (10 years)	April 2019 (4 years)	Nov-2021 (2 Years)	Jan-2016 (7 Years)
Bid variable	*Highest Royalty to ULB	Tipping Fee	Tipping Fee	Highest Royalty to ULB	Nomination
CBG/Power Offtake Price	For IMC : Rs. 5/Kg less than the market rate (No Off-take) For CGD Entity & Industrial Customers : Avg Rs. 65/KG	Rs. 4.88 Per KWH	Rs. 70 per KG	Rs. 70 per KG	Rs. 70 per KG
Offtake agency	Avantika Gas, L&T, TATA, HD Wire	DISCOM	Indian Oil, MNGL	OGMCs	OGMCs
Royalty paid by operator	Yes*	Not Applicable	Not Applicable	Yes	Not Applicable
Land Lease	Nominal lease for 20 years Concession Period by ULB	Nominal lease for 20 years Concession Period by ULB	Operator owns the land	Nominal lease for 20 years Concession Period by ULB	Lease rent at Rs. 3 lakhs/ month to APMC

Source: Secondary research, KPMG analysis.

* In case of Indore, no Royalty is being paid to Indore Municipal Corporation due to their inability to off-take the Bio-CNG @Rs. 5 less than the market price.

As the main objective is to develop an enabling framework for greater private sector participation in the waste management sector in India **the adoption of royalty as bid variable and payment of royalty to authority by the selected concessionaire will impact the overall financial viability of the projects** and would result in lower participation from potential bidders Royalty the same has been revoked from the Model Tender Documents prepared by MoHUA.

4.4. Financing mix, revenue streams and commercial viability

CBG projects face bankability challenges especially given many projects are smaller in scale and get classified under micro, small and medium enterprise (MSME) category of financing. Further, the category is relatively nascent without a long operating history. Projects (especially of smaller scales) continue to be implemented on EPC mode or with government grants.

From a financial standpoint, a project's financial viability is driven by three revenue streams. First revenue realizable from sale of CBG or power generated from the waste processed. Second revenue stream is the tipping/processing fee available to the project. Third revenue stream is from the sale of FOM. As in the case of WtE projects, viability gap grant financing can help reduce the project cost and improve viability.

Together, these levers are used to varying degrees to address project viability. However, in some instances, revenue from sale of CBG and bye-products are the only variables.

- **Revenue from sale of CBG:** A primary revenue source for bio-methanation projects is the sale of bio-CBG which provides upwards of 80% of revenue of CBG plants. The CBG produced can be potentially sold to multiple user categories.
    - **Sale to OMCs:** As mandated by MoP&NG under SATAT scheme, OMCs would purchase CBG from producers and sell to City Gas Distribution (CGD) entities all over India along with Administrative Price Mechanism (APM) / Non-Administrative Price Mechanism (NAPM) gas at uniform base price for use in Petroleum and Natural Gas (PNG) (D) & CNG (T) segments. Operational projects are provided with Rs. 70-75/ kg for CBG offtake under the scheme. The minimum guaranteed price under SATAT scheme is Rs. 54/Kg with prices being benchmarked to move in tandem with CNG prices. A CBG-CGD synchronization scheme from Gas Authority of India Limited (GAIL) as facilitator provides for procurement of CGD @Rs. /Metric Million British Thermal Unit (MMBTU) (~Rs. 54/Kg) along with compression charges of Rs. 8/Kg.
    - **Captive use by ULB:** In some cases, CBG was proposed to be sold to ULB as a captive user for running city buses like in Indore @ Rs. 95/Kg.
    - **Industrial / bulk users:** ULBs could also explore opportunities to sell CBG to industrial and commercial bulk users in the vicinity of the city.
- **Revenue from processing fee / tipping fee:** A few projects have sought to provide processing fee / tipping fee to augment the revenue streams available to projects. For instance, in Pune the processing fee is Rs. 570 / ton is provided. This fee is typically paid out of the ULB's general budget and is provided when the ULB is not able to provide source segregated waste to the project. Conversely, royalty is being charged by the ULBs for ensuring supply of source segregated wet waste in some cases.
- **Revenue from By-products:** Bio-methanation projects also have by-product as Fertilized Organic Manure (FOM) and slurry. The organic manure can be sold to fertilizer manufacturing companies such as Indian Farmers Fertilizer Cooperative (IFFCO) etc. which source them on a regular basis, as well directly to farmers if the market exists. Responsibility of marketing and distribution lies with the respective developers. The share of by products in total revenue is 15-20% considering 100 kg of wet waste generates 3 Kg i.e., 3% CBG and 8-10% of FOM @Rs. 3-4 per Kg.

- **Viability Gap Funding (VGF) grants:** Viability gap grants are a very useful tool to address operational viability of these projects. Grants for CBG projects are available under a variety of GoI schemes. However only one operational project in Indore (20 TPD) has leveraged the VGF grant.

Refer to Exhibit 4.4 for a snapshot of financing mix and revenue streams in select operational bio-methanation projects.

Exhibit 4.4 Bio-methanation - financing mix, and revenue streams – select operational projects

Parameter	Indore	Solapur	Pune	Chennai	Surat
Capacity (TPD)	550	400	300	100	50
Project Cost (Rs. in cr.)	178	110	65	25	12
Financing Mix					
VGF (% of project cost)	No VGF	No VGF	No VGF	No VGF	No VGF
Private (% of project cost)	100%	100%	100%	100%	100%
Operational Expenses					
OPEX per Tonne	Rs. 1914	Rs. 583* (Wet waste to electricity)	Rs. 344*	Rs. 1,333	Rs. 1,600
Revenue Drivers					
Sale of CBG/Power	IMC: Rs. 5/kg less than the market rate CGD Entity & Industrial Customers: Rs. 65/kg	Rs. 4.88/KWH	Rs. 70/Kg	Rs. 70/Kg	Rs. 70/Kg
Processing fee	Not Applicable	Not Available	Rs.570	Not Applicable	Not Available
Sale of FOM to farmers	3-4 Rs/Kg	3-4 Rs/Kg	3-4 Rs/Kg	3-4 Rs/Kg	3-4 Rs/Kg
Revenue Rs. lakh/month	**Rs. 36.23**	**Rs. 59**	**Rs. 79.38**	**Rs. 63**	**Rs. 47.28**

Source: Secondary research, KPMG analysis. * Only 50% feedstock processed relative to capacity.

4.5. Boundary conditions and enablers for success

Critical boundary conditions and enablers for success are summarized below:

- **Waste segregation is key:** For bio-methanation projects to be successful, it is essential that waste is segregated at the source. This means that organic waste, such as food waste, etc. must be separated from other types of waste such as paper, plastic, etc. The role of ULBs is pivotal in providing source segregated waste to the processing facilities.
- **Identified feedstock clusters:** For small-scale bio-methanation projects, cities can identify feedstock clusters such as agricultural markets or vegetable/fruit markets, where a large amount of organic waste is generated in a concentrated area. This can make collection and transportation of waste to the project site easier.
- **Pre-processing of waste:** After receiving source segregated waste, pre-processing is necessary for large-scale projects to ensure the feed is consistent and homogenous.
- **Offtake commitment**: To ensure the financial viability of bio-methanation projects, it is important to have a guaranteed offtake for the biogas/CBG produced. This could be achieved by linking the project to a user entity, such as a biogas-fired power plant or a CBG filling station. Alternatively, the ULB could guarantee to buy back the biogas produced.

- **Bankability**: Bio-methanation projects can be complex and expensive to develop, so it is important to ensure that they are bankable. They must be able to attract the necessary financial backing from lenders. Early market sounding and engagement with lenders can help ensure the bankability of a project.
- **Securing land:** The availability of land is often a key challenge for any waste management project, including bio-methanation projects. Cities are encouraged to provide land to the operator at a nominal cost. Alternatively, innovative co-siting can be explored where the project is located on land that is already being used for other purposes, to help address challenges related to land requirements.

4.6. Case Study: Pune CBG Plant

4.6.1. Background

Pune Municipal Corporation (PMC) set up a 300 TPD food/organic waste processing facility in April 2019, which has processed approx. 160,000 tonnes of food waste till date. The ULB partnered with Noble Exchange (NEX) which specializes in the processing of organic food waste using an Anaerobic Digestion (AD) technology in which micro-organisms'breakdown biodegradable waste to produce biogas and organic manure. Biogas is cleaned and purified to 96% purity to become Compressed Biogas (CBG). The Fermented Organic Manure is sold directly by NEX to individual farmers and FPO's at market driven pricing.

The plant is designed to handle pre-segregated food waste and doesn't accept mixed municipal solid waste. It has incorporated a semi-automatic food waste segregation-cum-crushing section especially designed to handle Indian food waste and ensures optimum segregation to maximize feedstock available for processing while ensuring minimal rejects (7-10%).

Component	Description
Present population	~ 60 lakh
Total waste generation	2100-2200 TPD
Total wet waste	900-1000
Collection, Transportation and Processing	>90% door to door collection
	>90% segregation
	>95% processing
Mechanical Composting Plants (3)	250 TPD
Bio CNG/CBG Plant (1)	300
Bio-Gas Plants (12)	60
BWGs & Home composting	300

PMC pays a tipping fee of INR 570/tonne for processed waste. This partly subsidizes the cost of processing as CBG prices are market linked and subject to variations. PMC has made available 14,000 sq. ft. land within city limits at Baner for setting up and operating the plant.

Project land of 5 acres located at Talegaon MIDC (35 km distance from Baner plant) is owned by concessionaire.

CBG sale: Under SATAT, CBG is sold through retail outlets operated by Oil Marketing Companies like Indian Oil and MNGL. NEX also sells CBG to private manufacturing companies like Mahindra and Asian Paints for replacement of conventional fossil fuels used in direct combustion applications, enabling them to achieve their Environmental Sustainability Goals.

Revenue Model

- **CBG current output**: Approx 45 Kg CBG per tonne of organic waste
- **Total estimated CBG production per day**: ~ 5.5 Tonne CBG per day
- **CBG price per Kg**: Rs. 70 approx.
- **CBG price per tonne**: Rs. 70,000 approx.
- **Total revenue for 5.5 TPD CBG**: Rs. 3,85,000 per day

Operational expenses include labor at crushing plant, slurry transportation, power and CBG transportation. It is estimated that operating margin from the plant (after deduction of overheads and expenses) is about 20%, thereby ensuring a 5–7-year payback.

4.6.2. Project Snapshot

Technology type	Anaerobic Digestion (AD)
Waste type	Organic/food waste
Project scope	Wet/organic waste processing
Implementation mode	PPP
Concession period	20 years
Design capacity	300 TPD
Operating capacity	125 TPD
FOM generated	~ 70-80 TPD
CBG generated	~ 45 kg CBG per Tonne of Organic Waste
Gas generation per 100 TPD	4500 kg/100 TPD
Land available	5 Acres
Project cost	Rs. 65 Crore
Operational since	2019
Bid variable	Tipping fee
Land lease cost	Owned by Concessionaire
Financing Mix	
Private Rs. cr. (% of project cost)	100%
Revenue drivers	
Sale of CBG	70 per KG
Processing fee	570 Per Ton
Reported revenue Rs. cr. (Fin. year)	~12 Cr.

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

4.6.3. Replicable project features

- PMC has partnered with a PPP operator. The PPP model is designed to allow design, financing, selection of technology and operations and maintenance by a private entity while the ULB is required to provide land and guaranteed waste quantity. While replicating this project model, a ULB can also buy back the CBG, if required, as in the case of Indore.
- Linkages for sale of byproducts – CBG, FOM with oil and compost marketing companies has ensured a steady revenue stream.

5 BIOREMEDIATION

5.1. Segment overview

India has over 2,300 dumpsites, collectively containing more than ~250 Million .[11] MT of legacy waste. This waste is the result of decades of poor waste management practices, such as open dumping, unsegregated collection, and lack of treatment facilities. The accumulation of legacy waste in these landfills has led to serious environmental and health problems, including air, water, and soil pollution.

India's dumpsites occupy over 17,000 acres of valuable urban land. About 100 dumpsites in India account for more than 65% (15.5 crore MT) of the total legacy waste. These dumpsites are spread across 25 states and 95 urban local bodies (ULBs). 14 of these dumpsites have been completely remediated, and 1.21 crore MT of legacy waste has been cleared. The remediation work for 16.5 crore MT of legacy waste has been awarded and is on-going.

Till date, ~339 dumpsites have been completely remediated and cleared of legacy waste, totaling 4.5 crore MT.[12] These sites have been converted into green zones and parks, such as the Deoguradia dumpsite in Indore, the Pimpri-Chinchwad dumpsite in PCMC, the Navi Mumbai dumpsite, and the Surat dumpsite. The remediation of legacy waste is ongoing at 1,800 dumpsites, with a total of 16.5 crore MT of legacy waste.

In 1989, the Deonar dumpsite in Mumbai was mined as a pilot case study for using material recovered in composting. In 2007, bioremediation of compacted old waste using bio-culture (sprayed from a tanker truck with a high-pressure pump) was attempted in Pune and Nasik. The waste was then turned into aerobic windrows. Excavators and odor-control sanitizers were also applied at the sites. Leachate produced by the sites was found to act as good bio-culture. Recyclable fraction obtained during the operation was taken away by waste pickers hired for the purpose.

This method of biomining found successful application in the Kumbakonam dumpsite in Tamil Nadu in 2015. Inorganic materials (including plastics and tyres) were recycled and reused. High calorific value components were acquired by cement factories for blending with coal and for use as an alternative fuel material. Since then, successful biomining projects have been executed at Indore, Bhopal, Noida, Vijayawada, Vadodara, Agra etc.

[11] Sbmurban.org
[12] Sbmurban.org
[13] SBM 2.0 operational guidelines

The Ministry of Housing and Urban Affairs recognizes that unlined landfills/dumpsites are a major source of pollution to air and water. The operational guidelines of Swachh Bharat Mission (SBM) 2.0 made it mandatory for cities with a population of less than 1 million to clear legacy waste sites by October 31, 2024, and cities with a population of more than 1 million to remediate their dumpsites by March 31, 2026. A central financial assistance of Rs. 550 per Tonne is provided for legacy waste processing under SBM 2.0.[13]

5.2. Scale, configuration, and project cost

There are two primary ways for remediating and reclaiming legacy dumpsites:

- **Capping:** Is a process of covering the dumpsite with a layer of soil and vegetation to prevent the release of leachate and methane. It is a relatively cheap option, but it is not always effective, especially if the dumpsite contains hazardous waste.
- **Biomining:** This is a process of using microorganisms to break down the waste in the dumpsite. It is a more expensive option, but it is more effective at removing hazardous waste and pollutants. The soil and recyclable materials can then be recovered, and the land can be reclaimed for secondary use.

According to the Solid Waste Management Rules, 2016 (SWM) Clause J of Schedule-I, biomining and bioremediation should be the preferred option for the reclamation of legacy waste. Capping should only be considered as a last resort, and it should only be used for a maximum of 10% of the residual waste after biomining.

Biomining is the use of microorganisms to extract materials of economic interest from legacy waste. However, the recovery of soil from decomposed mixed waste is the most important process. In addition, biomining is seen as a method of extracting and sorting valuable resources from piles of waste. The legacy waste remediation process includes excavation, stabilization, and segregation of stabilized waste. The major resources extracted from legacy waste are plastic, rubber, metal, textiles, glass, good earth/soil, Construction and Demolition (C&D), combustible dry waste (RDF) and inert waste. The end product, likely to be soil, is rid of toxic materials and hence becomes reusable. Findings from completed and ongoing dumpsite remediation projects in India with respect to scale and configuration are summarized below.

- The size of bioremediation projects varies depending upon the legacy waste quantum lying at the dumpsites. They can range from **1,000 MT to 2 Cr. MT,** which is the size of the biggest dumpsite in India at Greater Mumbai (Deonar and Mulund dumpsites). The projects reviewed have ranged from 1 lakh MT to 15 lakh MT.
- Depending on the type and characteristics of dumped waste, the fractions of recovered materials vary with mixed proportions of RDF, C&D waste, bio-earth/soil. Also, the recovery of land varies depending upon the quantum of Inert/processing rejects to be capped as per the scope of the project.
- There is a wide variation in the project costs across various projects given the site conditions, life of the site, pre-treatment to stabilize the waste, cost incurred on disposal of inert etc.

Refer *Exhibit 5.1* for salient aspects of select completed and on-going projects from various Indian cities with respect to above parameters. The trends discussed above are also reflected in projects under implementation.

Exhibit 5.1. Scale configuration and project cost

Parameter	Indore	Bhopal	Noida	Vadodara
Project Status	**Completed**	**Completed**	**Completed in Dec 2019**	**Completed in Dec 2019**
Technology type	Biomining and Bioremediation	Partial Biomining & Bioremediation and Partial Capping	Biomining and Bioremediation	Biomining and Bioremediation
Age of Dumpsite	50 years	47 Years	5 years	40 Years
Total Legacy Waste	15 Lakh MT	7.5 Lakh	1 Lakh MT	4.21 Lakh MT
RDF generated	~2,70,000 MT	~1,59,720 MT	~20,000 MT	~80,000 MT
Bio-Earth recovered	~8,00,000 MT	-	~69,000 MT	~2,90,000 MT
C&D Waste recovered	~1,90,000 MT	-	~11,000 MT	~34,0000 MT
Recyclables	1,50,000 MT	-	-	~118 MT
Dumpsite Area	100 Acres	37 Acres	4 Acres	14 Acres
Land Recovered	100 Acres	21 Acres	4 Acres	14 Acres
Project cost	Rs. 54 Cr	Rs. 52 Cr	Rs. 11.83 Cr	Rs. 33.26 Cr.

Source: Secondary research, KPMG analysis. Per ton processing cost may vary for similar legacy waste quantum depending upon the scope, cost of disposal of Inert and processing rejects.

5.3. Scope, Implementation mode, project structuring and bid variable

Most of the completed and on-going bioremediation projects in Indian cities have been done on Engineering Procurement & Construction (EPC) mode, where the agency/contractor is typically selected by the ULB through a competitive bidding process. Key findings from completed and on-going projects are summarized below.

- Dumpsite bioremediation is structured to include processing of legacy waste, utilization of RDF & recoverable waste and disposal of inert/processing reject waste as scope for operators/agencies. The developer is obligated to fulfill only waste processing and ensuring that RDF is utilized. Processing rejects/inert are sent to landfill for disposal or as provided in the concession agreement.
- Most projects have been competitively bid out on EPC mode by respective ULBs or competent authorities.
- Given that such projects are ecologically sensitive, it is preferred that technology, construction and operations risks have been passed on to a private developer who is well equipped with requisite credentials and experience to handle these risks.

Bid variable in Bio-remediation projects

- **Processing fee/ tipping fee:** Processing fee/ tipping fee (quoted as Rs./tonne) received by developer for processing, utilization/disposal of RDF and processing rejects/Inert.
- **Lumpsum Project Cost**: Some projects are awarded on the lowest lump sum project cost basis quoted by the bidder. Bhopal bio-remediation project was done on lumpsum project cost basis.

Exhibit 5.2 Scope, implementation mode & bid variable – select operational projects

Parameter	Indore	Bhopal	Noida	Vadodra
Project scope	Installation, processing (Excavation, Stabilization, segregation) & transportation of by products (RDF, Inert) for disposal	Installation, partial processing (Excavation, Stabilization, segregation) & partial capping and 5 years of O&M	Installation, processing (Excavation, Stabilization, segregation) & transportation of by products (RDF, Inert) for disposal	Installation, processing (Excavation, Stabilization, segregation) & transportation of by products (RDF, Inert) for disposal
Legacy Waste Quantum	15 Lakh MT	7.5 Lakh MT	1 Lakh MT	4.21 Lakh MT
Implementation mode	EPC	EPC	EPC	EPC
Bid Variable	ULB did it on its own	Lump sum cost	Processing Fee Per Ton	Processing Fee Per Ton
Period of Implementation	3 Months	6 Months	3 Months	3 Months
Duration operational	2 Years	3 years + 5 years O&M	1 year	15 Months
Financing Mix	100% by ULB	100% by ULB	100% by NOIDA	100% by ULB

Source: Secondary research, KPMG analysis

5.4. Financing mix, revenue streams and commercial viability

As seen above, bioremediation projects are being implemented on EPC mode assisted by the government grants. Swachh Bharat Mission 2.0 has earmarked a massive financial expenditure of 1,41,600 crores. The Government of India share will be ₹36,465 crores[14]. The balance amount will be contributed by, States and UTs/ ULBs/ Private Sector under PPP, as beneficiary contribution. A Central Financial Assistance of Rs. 550 per tonne is provided by the Government of India for legacy waste processing under SBM (U) 2.0.

From a financial standpoint, project financing viability is driven largely by two revenue streams. First revenue stream will be realizable from processing fee/ tipping fee paid per ton of legacy waste remediated. The second revenue stream is that from the sale of RDF.

The success of these projects depends largely on disposal of processed rejects and utilization of RDF. If these are not disposed properly, it will subsequently create another dumpsite. The cost of disposal of RDF/ processing rejects which is largely incurred on transportation of RDF to cement industries or other sources identified for the utilization of RDF should be cautiously assessed and covered in the overall project cost by the authorities.

Together, these levers are used to varying degrees to address project viability.

- **Revenue from processing fee/ tipping fee:** The projects are awarded to private agencies on a per ton processing fee basis. Processing fee (quoted as rupees/ton) received by developer for processing of legacy

waste (includes excavation, stabilization & segregation), utilization/disposal of RDF (transportation cost included in the per ton processing cost) and disposal of processing rejects/Inert in SLF or as per contractual obligation. The cost per ton varies depending upon the project scope and site conditions. For instance, in Noida the processing fee paid to the developer is Rs. 1150/ton whereas in the case of Indore where the ULB did the project on its own, the cost incurred is Rs. 360/ton.

- **Revenue from By-products:** The major resources extracted from legacy waste bioremediation process are combustible dry waste (RDF), some percentage of plastic, Rubber, Metal, Textiles, Glass, Construction and Demolition (C&D), good earth/soil and inert. The RDF and other recovered materials except good earth and Inert can be sold to generate revenue. Responsibility of forward marketing and distribution is entrusted with respective developers.

Refer *Exhibit 5.3* for a snapshot of financing mix and revenue streams in select completed and on-going projects.

Exhibit 5.3 Financing mix, and revenue streams – select operational projects

Parameter	Indore	Bhopal	Noida	Vadodara
Total Legacy Waste	15 Lakh MT	7.5 Lakh MT	1 Lakh MT	4.21 Lakh MT
Processing Capacity per Day	2000 TPD	600 TPD	1000 TPD	850 TPD
Project Cost	Rs. 54 Cr	Rs. 52.38 Cr	Rs. 11.93 Cr	Rs. 33.21 Cr.
Financing				
EPC	100% by ULB	100% by ULB	100% by ULB	100% by ULB
Revenue Driver				
Processing fee	ULB did it on its own	Lumpsum cost of Rs. 42 Cr. + Rs. 10 Cr. for O&M of 5 years	Rs. 1183/Tonne	Rs. 887/Tonne

Source: Secondary research, KPMG analysis

5.5. Boundary conditions and enablers for success

Critical boundary conditions and enablers for success are summarized below

- **Correct assessment of legacy waste quantum:** The quantification of legacy waste is crucial element as the project cost is directly proportional to it and vague assessment of legacy waste will lead to time and cost overrun.
- **No fresh waste dumping in the project area:** The project area should be clearly earmarked, and any dumping of fresh waste must be stopped with immediate effect once waste quantification assessment is done.
- **Bifurcated cost for processing and disposal:** Along with the total cost of processing, the total project cost must be the bifurcated cost for processing of legacy waste, disposal of inert material and cost incurred on transportation for disposal/utilization of RDF material separately. This will ensure that the processed waste is evacuated from the site and the site is cleared.
- **Offtake commitment for RDF**: To ensure proper disposal of RDF it is important to have a guaranteed offtake for the RDF prior to the start of the project. This could be achieved by linking the project to a user entity, such as nearby cement industries or a Waste to electricity plant.
- **Disposal of good earth/soil and inert**: The scope of work should clearly define the role of agency for proper disposal of good earth/soil (if not contaminated can be used in-situ for horticulture purposes by ULB or for filling up low lying areas etc.) and the disposal of inert in SLF or capping it.

- **Concession Agreement:** The effectiveness of concession management in dumpsite remediation hinges on clear contractual agreements between the concessionaire and the governing body to ensure accountability and set performance benchmarks, ensuring financial viability through adequate funding and cost recovery mechanisms, and engaging stakeholders to foster collaboration and support.
- **Site Management:** This requires conducting accurate site assessments to understand the composition and extent of waste, utilizing advanced technologies, and leachate management systems to enhance remediation efficiency, and implementing continuous monitoring and reporting systems to track environmental parameters and ensure regulatory compliance, thereby maintaining site safety and effectiveness.

5.6. Pre-feasibility and baseline assessment

There could be several potential environmental risks associated with bio-remediation projects and therefore, a plan addressing these potential risks should be kept ready. Most of the conditions present at the landfill and its surroundings will be unique to the specific landfill, and specific to the age of the waste being excavated.

Majorly the risks would be associated with proper management of hazardous waste that may be uncovered during the operations of reclamation, managing the releases of gases, odors, its associated risks to human health and controlling any fire, subsidence, or collapse. Environmental risks can be managed well if considered in advance of the operations and appropriate mitigation measures have been designed by the executing agency.

The steps for dumpsite remediation are (a) Pre-feasibility/baseline assessment and site preparation, (b) excavation, (c) bio stabilization of waste and (d) screening and recovery of recyclables.

The pre-feasibility assessment is the critical first step in biomining operations. It deliberates the relevant factors of a biomining operation, including economic, technical and legal factors, and timeline considerations. Site environment parameters such as baseline study of heavy metals in surface and subsurface soils and water, rainfall, soil type, surface hydrology, topography, wind direction etc. shall be studied before and after bioremediation. Periodic study should also be carried out after completion of bioremediation to check for any adverse effects in the surrounding area.

5.7. Legacy dumpsite management control

The Central Pollution Control Board (CPCB) of India has issued comprehensive guidelines for dumpsite remediation in 2019 which provides a systematic and environmentally sound framework.

- **Assessment and Inventory:** The first step in managing legacy dumpsites is to conduct a thorough assessment and inventory of the site. This involves identifying the location, size, and composition of the waste. The CPCB guidelines recommend using advanced technologies such as drones and ground-penetrating radar (GPR) to map the extent of the waste and assess its characteristics.
- **Bioremediation and Biomining:** The CPCB guidelines emphasize the use of bioremediation and biomining techniques for the treatment of legacy waste. Bioremediation involves the use of microorganisms to degrade organic waste, while biomining focuses on the recovery of valuable materials from the waste.
- **Leachate Management:** Leachate, the liquid that percolates through the waste, can contaminate groundwater and surface water. The CPCB guidelines recommend the installation of leachate collection and treatment systems to prevent environmental contamination.
- **Fire Control and Safety:** Legacy dumpsites are prone to fires due to the presence of combustible materials. The CPCB guidelines outline measures for fire control and safety, including the installation of firebreaks, regular monitoring of temperature and gas emissions, and the provision of firefighting equipment.
- **Use of Recovered Space:** Once the legacy waste has been treated and the site has been remediated, the recovered space can be used for various purposes. The CPCB guidelines suggest that the reclaimed land

can be used for green spaces, recreational areas, or even for the construction of infrastructure projects.

- Monitoring and Reporting: Continuous monitoring and reporting are essential for the effective management of legacy dumpsites. The CPCB guidelines recommend regular monitoring of environmental parameters such as air quality, water quality, and soil quality.

Link to the guidelines: https://cpcb.nic.in/technical-guuidelines/

5.8. Case study: Bioremediation of dumpsite at NOIDA

One of the most successful bioremediation projects in India is the Bioremediation of 4 acres of land in Sector 54 NOIDA. The New Okhla Industrial Development Authority (NOIDA) intended to implement the project titled- Remediation of Sector 54 Dumpsite through Bio-mining and Reclamation of existing solid waste dumpsite in a scientific manner at Sector 54 Dumpsite in New Okhla Industrial Development Authority.

Conceptualized in 2017 and bid on 100% outsourced model, the Remediation of Sector 54 NOIDA project was awarded in August 2018 and commercially started in December 2018.

M/s Zigma Global Environ Solutions Private Limited was given the contract for remediation of the Sector 54 dumpsite, having qualified as the successful bidder through a Quality and Cost Based Selection (QCBS) tender of NOIDA. The project scope includes installation of machinery, sorting and segregation, recovery of city compost and RDF, transportation of RDF and inert, complete remediation of the site spread over 4 acres, project awareness and extension activities, followed by exit.

About 100,000 MT of waste is being processed from Sector-54 Noida and a considerable amount of by products are recovered. This includes around 20,000 MT of RDF which is sent to cement plants in Madhya Pradesh, around 60,000 MT of bio-earth which is being used by Horticulture department for plantation and

[14] SBM (U) operational guidelines

some amount of bio-earth which is being provided to farmers. Approximately 11,000 MT of C&D materials and inerts are also recovered which are used for filling low lying areas.

The project was dubbed Wasteland to Wetland. Under it, the entire reclaimed area was converted into a wetland. It was declared the fastest project of land reclamation in India so far and was the recipient of the 2019 Smart City Award for Best Urban Development Project—Greenfield Development awarded by the Union Ministry of Housing and Urban Affairs (MoHUA).

5.8.1. Project Snapshot

Technology type	Biomining and Bioremediation
Waste type	Legacy Mixed
Design capacity	1000 TPD (70-80%)
RDF generated	~20,000 MT
Bio-Earth recovered	~69,000 MT
C&D Waste recovered	~11,000 MT
Land Recovered	4 Acres
Project cost	Rs. 11.93 Crores
Project scope	Installation, sorting and segregation, recovery, and transportation of by products
Implementation mode	100% outsourcing (EPC)
Period of Implementation	6 Months
Duration operational	1 years
Financing Mix	100% by NOIDA
Revenue drivers	
Processing fee	Rs. 1183/Tonne

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

5.8.2. Replicable project features

BIOREMEDIATION

- **Rigor in project preparation:** The project was conceptualized by NOIDA, with support from a strong technical team along inputs from various industry experts. The focus was to onboard an agency with proven experience in carrying out similar projects, and hence QCBS was given preference to overall cost.
- **Selection of model of execution:** With limited experience in the sector, and based on the inputs of technical experts, it is decided to opt for 100% outsourcing model. The objective was to remediate the dumpsite meeting all environmental compliances. Scientific disposal being one of the priorities, it was desired to onboard an agency with experience and connect with the cement industry. Tie ups with Horticultural Department were also done for disposal of the bio-earth.
- **Bifurcated cost for Processing and Disposal:** Along with the total cost of processing, the tender also asked for bifurcated costs for processing of legacy waste, disposal of inert material and disposal of RDF material separately. This was done to ensure uptake of all RDF and inert material from the site within the timeline.

6

ALLIED APPROACHES

6.1 Construction and Demolition waste

6.1.1 Segment overview

C&D waste generation in India is increasing due to rapid urbanization, industrialization, and infrastructure development. An estimated ~12 million tonnes of C&D waste is generated in India annually and constitutes 5- 20% of the waste generated in ULBs, depending on the level of construction and development activities in different cities. Construction and Demolition (C&D) waste comprises waste generated from construction, renovation, repair, and demolition of civil structures. The composition of C&D waste varies based on differences in building material used, construction style and regions. A 2001 study[15] estimates that soil, sand, and gravel constitute about 36% of C&D waste, followed by 31% of bricks and masonry, 23% of concrete, 5% of metals, 2% of wood and 3% of other materials.

Government programmes to reduce particulate pollution have increased the focus on developing a proper strategy for effective reduction in dust emissions, attributed mainly to the construction and demolition activities associated with infrastructural development. The National Clean Air Programme of the Ministry of Environment, Forest & Climate Change, enlisted 132 non-attainment cities aiming for a 20-30% reduction in particulate pollution by 2024 from the levels in 2017. In addition, the 15th Finance Commission has recommended a 5% annual reduction in particulate pollution over a period of 5 years and has selected 42 million plus cities for direct funding to the ULBs for taking steps to reduce air pollution. Based on these propositions, establishing C&D waste processing facilities is crucial for these cities to aid in minimizing air pollution along with proper management of C&D waste.

[15] Source: Technology Information, Forecasting and Assessment Council (TIFAC). 2001

C&D waste is largely inert with a significantly high recycling and reuse potential (more than 90%). Yet less than 20-40% of C&D waste is recycled. India has 41 C&D waste processing facilities with 13,000 TPD capacity at an operational utilization of 60-70%. The inefficiencies are typically due to inconsistent/intermittent waste supply. The processing technologies adopted by C&D waste recycling facilities to can be broadly categorized into two types:

- **Dry processing:** Dry processing is the initial step for recycling C&D waste including processes like crushing and screening of large lumps of aggregate material in the C&D debris stream into smaller sizes suitable for use in construction or for further downstream processing.
- **Wet processing:** After proper sizing and sorting of the aggregate material recovered from dry line processing, it may need to undergo additional wet line processing before being reused in certain construction projects. The waste materials are fed into a hydro cyclone or water-based gravity separator which separates the finer materials such as sand, silt, and clay, while the heavier materials like stones, metals, and plastics are removed using a sink-float separation process. Additionally, the resulting solid and liquid fractions can be separated to allow for the recycling and reuse of process water.

C&D recycling also provides a cost-effective alternative to multi-treatment or disposal processes by reducing energy and tipping costs as well as increasing the lifespan of mines and landfills. However, due to limited recycling infrastructure for C&D, a higher proportion of waste is being disposed rather than being recycled. Identification of C&D waste generators (non-Bulk Waste Generators (BWGs)) and collection of C&D waste are critical bottlenecks in managing C&D waste. Owing to the uncertainty in nature of waste generation, it is difficult to estimate the volume expected.

Challenges involved in C&D Waste Management

- Lack of inventory
- Inadequate focus on estimation and characterization of C&D Waste
- Land shortage/scarcity for C&D waste disposal, especially in urban areas where there is limited space for landfills and other waste disposal facilities
- Lack of monitoring capacity for construction/demolition industry (e.g., no permits) leading to illegal dumping of waste
- Lack of experience in C&D waste management particularly in the use of PPPs
- Concern about finances and business case owing to high costs of collecting, transporting, and processing C&D waste, and limited market for recycled materials
- Lack of urgency/priority compared to MSW, as MSW is generated more frequently and in larger quantities than C&D waste
- Under-budgeting of projects
- Non-standardized contracts
- Lack of confidence in recycled products made from C&D waste
- Concerns about the economic viability of recycled products

C&D waste has become a significant environmental concern due to the large quantities of waste generated and the challenges associated with its proper disposal. The economic potential of C&D waste in India is significant. It is estimated that the economic potential for around 30,000 TPD generation of C&D waste, from sale of byproducts such as aggregate, sand and soil and value-added products such as paver blocks, tiles, bricks, etc., could range up to Rs. 500 Cr annually.

6.1.2. Scale, configuration, and project cost

The percentage of C&D waste out of the total solid waste generated in million-plus cities is 20 to 25%. Two C&D waste projects of Shastri Park, East Delhi and Gurugram were reviewed under this exercise. Both these

projects are of 1000 TPD capacity, spread over 2.5 acres and 4 acres respectively. Findings from the plants with respect to scale and configuration are summarized below:

Exhibit 6.1 C&D – Scale and land requirement – select operational projects

Parameter	Delhi – Shastri Park	Gurugram
Technology type	Wet Process Technology	Wet Process Technology
Waste type	Segregated C&D waste	Segregated C&D waste
Waste processed	500 TPD	350 TPD
Quantity/volume of output	1000 Tonnes	900 Tonnes
Land Available	2.5 Acres	4 Acres
Project cost	Rs. 21 Crore	Rs. 20 Crore
Products generated	90 Tonnes/100 TPD	90 Tonnes/100 TPD

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

- The C&D waste recycling plants require segregated waste with not more than 5% rejects, as a prerequisite for efficient processing and recycling.
- A 50-100 TPD capacity C&D waste processing plant, based on wet processing technology requires about 2- acre land, and about 1 acre of land for every incremental 100 TPD. Accordingly, a 1000 TPD facility can be set up in a ~10-acre facility. Cities with higher C&D waste generation more than 500 TPD may need to plan for more than one processing facility to optimize and waste transportation costs. Smaller towns can also go for mobile crushing units (where generation is < 50 TPD) or develop a cluster-based shared facility.
- Project cost of operational projects is in the range of Rs. 17 – 20 Cr for a 1000 TPD capacity plant. Minimum economic size for a C&D facility is 100 TPD.

6.1.3. Scope, Implementation mode, Project structuring and Bid variable

Most operational C&D waste processing projects in Indian cities have been set up in PPP mode, where the developer is typically selected by the ULB through a competitive bidding process. Key findings from operational projects on implementation mode are summarized below.

- **Scope of project:** Most C&D waste projects have been structured as **integrated processing facilities** wherein collection, transportation, processing, and disposal of rejects/inert falls under the scope of the concessionaire. In these projects, ancillary off-site facilities such as access roads, electrical connections, water supply etc. are required to be provided by the ULB.

  For instance, in the integrated C&D waste projects at Delhi and Gurugram, the operator's scope covers waste collection & transportation, processing and disposal of rejects/inert in the already available landfill. Here, the selected developer is entrusted with responsibility for waste collection and transportation within an earmarked area (either covering the whole city or part of the city) apart from the responsibility of setting up the processing facilities. The ULB/Authority in these projects has provided Sewage Treatment Plant (STP) water (at Rs 7/KL) to be utilized in washing. In addition, the normal industrial tariff of electricity is being charged at Rs. 15/Unit.
- **Project structuring:** C&D waste processing projects have been competitively **bid out on PPP mode** by respective ULBs or competent authorities. Although a variety of PPP formats are in vogue, C&D waste processing projects have been largely bid out on a Design Build, Own, Operate, Transfer (DBOOT) format. The concession period of these plants is typically 15 – 25 years.

Often, setting up and operationalizing the mechanism of collection and transportation of C&D waste to the processing facility is handled by both ULB and private operator. The designated collection points or locations for the non-bulk waste generators to dump C&D waste in small quantities are notified by the ULB and thereafter transportation of the waste from these collection points up to the processing facility is undertaken by the private operator. It is in the purview of the ULB and competent authorities to mandate BWGs and government agencies to transport their waste directly to the processing facility.

The commercial viability of C&D Waste processing projects is achieved mainly through revenue generation from tipping fee/processing fee paid by ULB to the concessionaire and through sale of C&D waste recycled products. The most common bid variable for C&D waste projects in India is the tipping fee (quoted as rupees/ton received) payable to the developer at the plant. Both the Shastri Park, East Delhi and Gurugram C&D projects have been bid based on processing/tipping fees.

6.1.4. Financing mix, revenue streams and commercial viability

- **Revenue from processing fee/tipping fee:** Out of the two major revenue streams available for C&D Waste processing projects, the tipping/processing fee tends to be a large/integral component in projects where the scope includes collection, transportation, processing, and disposal of inert/rejects in the landfill. The tipping/processing fee is typically paid out of the ULB's general budget. The bulk waste generators mandated to transport their waste directly to the processing plant are charged by the plant operator in the form of a processing fee on a per ton basis.
- **Revenue from the sale of C&D waste recycled products:** The ongoing growth in the infrastructural development sector across the country has accelerated the demand of construction materials. This has led to increased exploitation of natural resources like soil, stone, sand, and limestone, leading to associated challenges like higher costs of such materials on the one hand, and lesser supply due to restrictions imposed on illegal mining activities on the other. In this context, recycled C&D waste products serve as a perfect alternative to supplement the use of primary construction materials, thereby helping in the reduction of demand and requirement for virgin materials and natural resources.

  For instance, recycled C&D waste products such as recycled aggregates, recycled concrete aggregates, manufactured sand/soil, bricks, curb stones, paver blocks and tiles etc. have potential uses in construction materials, road construction, or construction of non-load-bearing structures.

6.1.5. Boundary conditions and enablers for success

- Promoting & creating markets for recycled products
- Developing proper marketing strategies for the offtake of recycled products
  - Preferential buyback by government and private entities
  - Ensuring that the use of recycled C&D waste products is included at DPR and Tender preparation stages itself
- Developing a strategy to increase awareness and acceptability of recycled products among consumers
  - Eco-labelling and green certification of products
- Developing a business case or model that would work in specific cases or conditions without draining the finances/budget
- Minimizing the cost of recycling processes
- Developing enabling/implementing mechanisms such as policy and regulatory frameworks, advisory, and by-laws to mandate the use of C&D waste recycled products in government projects and in projects by private developers
- Reduction of Goods & Service Tax (GST) on C&D waste processed products from the present applicable rate
- Exemption of Green tax on C&D Recycled products and transportation

- Capacity building support for conducting a proper initial feasibility study, preparation of DPR and adequate monitoring through trained personnel

  City officials may understand the broader aspects of C&D waste management but require support to develop tailor-made solutions to their specific needs

Exhibit 6.1 C&D – Scope, Implementation mode and Bid variable – select operational projects

Parameter	Shastri Park	Gurugram
Project scope	Collection, Transportation, Processing & Disposal	Collection, Transportation, Processing & Disposal
Implementation mode	PPP-DBOOT	PPP-DBOOT
Capacity	1000 TPD	1000 TPD
Concession period	15 Years	25 Years
Duration operational	8 years	8 years
Bid variable	Tipping Fee	Tipping Fee
Price escalation	Fixed 3.5% YOY	NIL
Land lease cost	-	Rs. 1/sqm

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

The **break-even period for most of C&D projects is 5-6 years**. However, their performance is largely dependent on supply of waste and support of governments in sale of byproducts.

Exhibit 6.2 C&D – Financing mix, and revenue streams – select operational projects

Parameter	Shastri Park	Gurugram
Capacity	1,000 TPD	1,000 TPD
Project Cost	Rs. 21 Cr.	Rs. 20 Cr.
Financing mix		
VGF (% of project cost)	No VGF	No VGF
Private (% of project cost)	100%	100%
Revenue drivers		
Sale of Recycled products	Aggregate (Rs 275-300/tonne), Sand (Rs 525-550/tonne), Concrete blocks (Rs 25-30/unit)	
Tipping fee for transportation	Rs. 375/tonne	Rs. 360/tonne
Processing fee for BWG	Rs. 444/tonne	Rs. 205/tonne

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

6.1.6. Case Study: C&D Waste Management Plant at Shastri Park, New Delhi

Background

The C&D waste management plant at Shastri Park, New Delhi was inaugurated in 2016 by Municipal Corporation of Delhi (MCD) to recycle and process 500 TPD of C&D waste initially. Owing to increased C&D waste generation, the plant capacity was augmented to 1,000 TPD. Spread over an area of 2.5 acres, the plant receives C&D waste from 54 designated collection points.

The project was bid on a PPP-DBOOT mode with a 15-year concession period and commissioned in April 2015. Catering to a waste generation of 850 TPD, the plant currently operates at its designed capacity of 1000 TPD. The project is an integrated C&D waste management facility, and its scope includes waste collection, transportation, processing, and disposal. For efficient recycling and operationalization, the facility is equipped with electronic weighbridge and CCTV enabling remote monitoring and control.

Developed and operated by M/s Indo Enviro Integrated Solutions (P) Ltd, the plant has pioneered wet processing technology, minimizing dust and noise pollution to recover 95% of waste. The recycled products are utilized by various government departments, facilitated by governmental regulations in place, as well as by private developers.

Project Snapshot

Technology type	Wet processing technology
Waste type	Mixed
Design capacity	1,000 TPD
Recycled products generated	~800-900 TPD
Land available	2.5 Acres
Project cost	Rs 21 Cr. | ~ Rs. 2 Cr./100 TPD
Project scope	Collection, Transportation, Processing & Disposal
Implementation mode	PPP-DBOOT
Concession period	15 years
Duration operational	7 years
Bid variable	Tipping Fee
Land lease cost	Rs 1/ Sq.mtr
Financing Mix	
VGF Rs. Cr. (% of project cost)	No VGF
Private Rs. Cr. (% of project cost)	100% privately funded
Revenue drivers	
Sale of Recycled products Rs. /TPD	Rs.
Processing fee Rs. /Tonne	Rs. 444/tonne % of price escalation year-on-year – Fixed 3.5% YOY
Tipping Fees for C&T Rs/Tonne	Rs. 375/Tonne

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

Replicable project features

- **Project feasibility assessment:** The project was initially designed for 5 years and later the capacity was enhanced from 500 to 1000 TPD based on the careful study of the project area (cluster project) with waste generation and projection patterns for project design period of 20 years.
- **Land availability:** Land for setting up project facility and collection centers was identified before the project was bid out.
- **Assured offtake of recycled products at pre-defined rates:** Delhi government notified and mandated the use of at least 17-20% of C&D waste recycled products in government projects and in projects by private developers as per the by-laws.
- **Project modality for operations and generating revenue:** The bid variable for the project is processing/ tipping fees per tonne basis. The ULB pays the tipping fee for C&D waste collected from designated collection centers. However, in case the C&D waste is being collected directly from a generator availing the on-call service for pick of C&D waste from doorsteps, the fee is paid by the generator (ULB and non-bulk waste generators do not pay any processing fee and operator has to recover the operations cost and generate profit through the sale of bye-products). Lastly, bulk waste generators (generating more than 600 TPD or as defined under the by-laws) are mandated to transport their waste directly to the processing plant at their own cost and are charged a processing fee on a per tonne basis by the plant operator.

The common challenges C&D waste projects face, such as land availability, continuous feed of segregated C&D waste and assured offtake of bye-products at pre-defined rates were duly addressed in the Delhi's Shastri Park C&D waste project.

6.2. Material Recovery Facilities

6.2.1. Segment overview

A Material Recovery Facility (MRF) is a building which is used to receive, sort, process and store recyclable materials which would be further shipped and marketed to end-users. An MRF accepts materials, whether separated or mixed, and separates, processes and stores them for later use as raw materials for remanufacturing and re-processing. The main function of an MRF is to maximize the quantity of recyclables processed, while producing materials that will generate the highest possible revenue in the market. MRFs can also function to process wastes into feedstock for biological conversion or into a fuel source for production of energy.

Transformation of segregated solid waste into a new product or utilizing it as raw material for further manufacturing and production processes with environmental and economic benefits is the basic principle behind recycling. In India, recycling at the city level is achieved mainly through informal sector or through authorized recyclers that are supplied with segregated dry waste to recover the recyclable fraction. To maximize the separation of recyclables from the collected dry waste, it is essential for a ULB to set up an MRF. This will help in opening avenues for revenue generation, reducing environmental impact and enabling the adoption of 3R principles, concept of circular economy, and the Integrated SWM (ISWM) hierarchy indicating dry waste recycling as preferred waste management strategy.

Types of MRFs

- **Based on input waste quality:**
  - A —dirty MRF receives mixed waste which requires labour intensive sorting activities to separate recyclables from mixed waste.
  - A —clean MRF is a facility that accepts source separated or mixed recyclable material.
  - A —clean MRF reduces the potential for material contamination.

- **Based on scale and automation**
  - Small MRFs (less than 10 TPD) where segregation is done manually (such as in the New Delhi Municipal Council (NDMC) area, select large garbage stations are also manual MRF).
  - Large MRFs (larger than 100 TPD) like those in Indore and Pune have intake of over 100 tonnes per day and are mechanized. Such MRFs are equipped with manual sorting chambers with long conveyer belts as well as bag openers, trommels, magnetic & eddy current separators, density separators, colour-based separators, bailing machines etc. In some large cities, MRFs also have static compactors and thus act as Material Recovery Facility-cum-Garbage Transfer Stations.
- **Major equipment in a mechanized MRF:** The equipment required in an MRF will depend on extent of segregation. For mixed waste, sorting lines may be needed. However, if all material is separated at source, less sophisticated methods could be used.

Exhibit 6.4 Scale and land requirements

Parameter	Indore	Pune
Technology type	Mechanized	Mechanized
Waste type	Segregated	Segregated
Designed Capacity	400 TPD	150 TPD
Waste processed	300 TPD	100 TPD
Quantity/volume of output	300 TPD	100 TPD
Land Available	4.5 Acres	1 Acre
Project cost	Rs. 50 Crore	Rs. 20 Crore

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

6.2.2. Scale, configuration, and project cost

Findings from key operational MRFs in India with respect to scale and configuration are summarized below.

- The percentage of recyclables out of the total solid waste is around ~10 to 20%. Recovering this valuable fraction with a potential for revenue generation is made possible through the MRFs.

- Source segregation of dry waste is critical for enabling the proper recovery of recyclable dry waste fractions of acceptable quality. The mixing of dry and wet waste degrades the quality of recyclable fractions for further processing or reuse.
- Additionally, the MRFs can be set up easily, requiring less time usually ~ 8 to 9 months for construction and operationalization.
- MRFs require sufficient space for carrying out the sorting of recyclable materials such as paper, plastic, metal, glass, textile etc. and storage of separated materials, however the land footprint for setting up MRFs is usually on the lower side.

6.2.3. Scope, implementation mode, project structuring and bid variable

Operating a standalone MRF solely on the revenue from byproducts like recyclables and RDF is often financially challenging. Both standalone and integrated MRFs face significant leakage loss. Many valuable recyclables are extracted by door-to-door collectors before reaching the MRF, leaving behind low-value items that ultimately end up as RDF. The value of recovered recyclables is typically 3-5 times that of RDF. For design purposes, most concessionaires estimate a recyclable recovery rate of 3-6%. Even with a Public-Private Partnership (PPP) model, it can be difficult to monitor every door-to-door collector. The Chandigarh Municipal Corporation has an MoU with door-to-door collectors, allowing them to recover and sell valuable items from the waste as an additional incentive to their salary.

MRFs can be constructed as standalone projects or as components of integrated waste management systems. In both cases, the PPP model is the most suitable (although a few ULBs opt for the EPC + O&M model). The concession period for standalone MRF projects ranges from 5 to 20 years. Either a tipping fee or a combination of a tipping fee and Viability Gap Funding (VGF) is used as the bidding criterion.

Main obligations of ULB

1. Providing suitable encroachment free land for setting up the facility, free of cost or at a nominal rate.
2. Providing good quality segregated dry waste to the concessionaire comparable to the designed capacity of the plant.
3. Timely collection and transportation of fresh waste to the MRF site.
4. Timely disposal of processing rejects (if in ULB's scope).
5. Timely payments to the concessionaire as per mutually agreed timelines or always ensuring sufficient funds in the escrow account.
6. Adequate support to the concessionaire in availing EC, Consent to Establish (CTE), Consent to Operate (CTO) and other statutory clearances (if in the scope of concessionaire).
7. Timely payment to independent Engineer (if applicable).
8. Regular monitoring of the project.

Main obligations of the concessionaire

1. Ensuring the quality of civil work and machinery is in line with best industry practices.
2. Providing adequate storage area for storing processing byproducts and ensuring proper fire safety of the plant especially the storage shed.
3. Construction and commissioning of the plant as per agreed timelines.
4. Operating the plant as per mutually agreed Service Level Benchmarks and ensuring best quality of by products as a result of waste processing.
5. Timely disposal of processing rejects (if included in the concessionaire's scope).
6. Ensuring least breakdowns and quick corrective actions.
7. Compliance with statutory norms including air emission norms prescribed by State Pollution Control Board (SPCB) and Central Pollution Control Board (CPCB).
8. Handover of the plant to ULB in good condition at the end of the concession period.

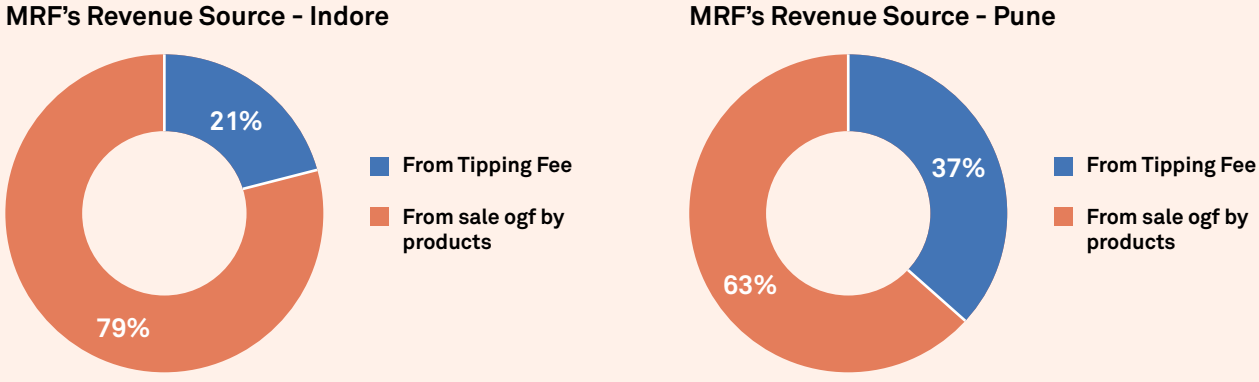
6.2.4. Financing mix, revenue streams and commercial viability

Commercial Viability: To make MRFs financially viable, annuity-based tipping fee model or a combination of VGF + tipping fee model is needed to successfully operate the MRF in PPP mode. The amount of tipping fees and VGF for standalone MRFs depends on the quantity of waste, waste characteristics, leakage losses, distance of potential recyclers and RDF buyers from the MRF, extent of instrumentation and automation, and revenue model (usually ownership of processing byproducts lies with the concessionaire). Land is provided by the ULB either free of cost or at a very nominal rate (normally Rs.1/sq.m).

Revenue: The source of revenue for a typical MRF is the sale of recyclables and RDF and tipping fee. For instance, Indore has a 400 TPD MRF built at a cost of Rs. 50 Crore and zero VGF and is being operated in DBFOT mode for 16 years concession period. The plant is currently being operated at 300 TPD capacity where the concessionaire is being paid a tipping fee of Rs. 35,25,000 on quarterly basis for 300 TPD intake. Recyclables and AFR are sold at an average price of Rs.12 and Rs. 1.63 per kg respectively.

On the other hand, Pune has a 150 TPD RDF plant operating at 100 TPD capacity. The plant was built at a cost of Rs. 20 Crore on DBOT model for 20 years period. The concessionaire earns a tipping fee of Rs. 420/MT. Recyclables and AFR are sold at an average price of Rs. 17.5 and Rs. 2.21/kg respectively.

Exhibit 6.5 Disaggregation of revenue source in the reference projects



6.2.5. Boundary conditions and enablers for success

- Setting up large mechanized MRFs is fruitful only when segregation at source is practiced. In Indian conditions where dry waste is mixed with impurities, MRF machineries, especially the conveyer belts face frequent breakdowns. Thus, segregation at source should be highly promoted.
- Where space is not a constraint, large cities may set up integrated MRF & Garbage Transfer Stations (GTS) facilities which can save fixed costs to some extent.
- Cluster approach requires long distance intercity secondary transportation. MRF + GTS plays an important role in reducing the amount and volume of waste to be transported up to centralized processing and disposal. Thus, reducing secondary C&T cost is vital for adopting cluster approach.
- Investment in R&D is important to maximize resource recovery. For instance, low value plastics such as wrappers, polybags etc. can be used for road construction or converted into oils. PET bottles can be used to produce polyester.
- A mapping of pan India waste processing plants and potential buyers of recyclables and RDF will be beneficial for both parties.

Exhibit 6.5 Scope, Implementation mode and Bid variable – select Material Recovery Facilities

Parameter	Indore	Pune
Project scope	Processing	Processing
Implementation mode	DBFOT	DBOT
Capacity	400 TPD	150 TPD
Concession period	16 years	10 years
Duration operational	4 years	3 years
Bid variable	Tipping Fee	Tipping Fee
Price escalation	5% per year	5% per year
Processing/Tipping fee	Rs. 35.25 Lakh on quarterly basis for 300 TPD intake	Rs.420/MT
Land lease cost	Rs. 1/Sq.m/year	-

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

Exhibit 6.6 Financing mix, and revenue streams – select Material Recovery Facilities

Parameter	Indore	Pune
Capacity	400 TPD	150 TPD
Project Cost	Rs. 50 Crore	Rs. 20 Crore
VGF (% of project cost)	No VGF	Rs.6.71 Crore
Private (% of project cost)	Rs. 50 Crores	Rs.13.29 Crore
Revenue through Sale of by products	Unit Price: Rs. 10.35/kg for recyclable Rs. 2.28/kg for AFR Rs. 1.41/kg for RDF	Gross Revenue ~ Rs.2.6Cr Unit Price: Rs. 10.35/kg for recyclable Rs. 2.28/kg for AFR Rs. 1.41/kg for RDF
Processing fee	Rs. 130/MT	Rs.420/MT

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

6.2.6. Case Study: Pune Material Recovery Facility

Pune generates approximately 2,000 tonnes of MSW daily. By 2025, it is projected that the Pune Municipal Corporation (PMC) will generate and manage 3,255 tonnes of MSW per day. Approximately 70 per cent of the MSW is generated by households, while hotels, restaurants, and other commercial establishments together account for the remaining 30%.

Collection and Transportation: Approximately 87% of MSW in Pune is collected and treated. The PMC organizes the transportation of solid waste through a fleet of vehicles and dumper-placers. Collection is managed by different entities, based on the origin of the waste. Solid Waste Collection and Handling (SwaCH) cooperative is collecting over 52% of the MSW through its network of waste pickers. PMC vehicles collect 17% (350 tonnes) per day of waste, private non-affiliated operators retrieve 10% (200 TPD), while rest of the waste is managed by residents.

Processing: The construction of the 150 TPD MRF commenced in March 2020 and was completed in November 2020. The project was awarded to Gujarat based NEPRA Resource Management Pvt Ltd on DBFOT model.

The main components of the plant included – screening, density separation, optical sorting, metal separator, quality checking and size reducing machinery. Unlike typical waste management PPP projects, an escrow account was not created. The plant will require asset replacement (mechanical and electrical items) after 15 years.

6.2.6.1 Project Snapshot

Technology type	Mechanized MRF
Waste type	Segregated
Design capacity	150 TPD
RDF generated	100 TPD
Area	1 Acre
Implementation mode	PPP-DBFOT
Concession period	20 years
Construction Period	8 months
Bid variable	Tipping Fee
Project scope	Dry waste Processing
Land lease cost	Free
Financing Mix	
Project cost	Rs 20 Cr.
VGF	Rs. 6.71 Cr. (33.6%)
Concessionaire's share in Capex	Rs.13.29 Cr. (76.4%)
Revenue drivers	
Unit Price of Recyclables	9.84/kg for recyclable 2.34/kg for AFR 0.43/kg for RDF
Tipping Fee	Rs. 420/MT
Total Annual Revenue	Rs. 4.13 Cr
Penalty Mechanism	
Penalty on under processing	10% of O&M fees if plant is running at 80 % capacity in the entire month 5% of O&M fees if plant is running at 90 % capacity in the entire month

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

6.2.7 Integration of MRF in EPR

Extended Producer Responsibility (EPR) is a policy approach that places the responsibility for the end-of-life management of products on producers. It aims to incentivize producers to design environmentally friendly products and ensure that they are properly disposed of or recycled. EPR systems require producers to take accountability for the entire lifecycle of their products, including collection, recycling, and safe disposal. This

[16] Sbmurban.org

approach reduces the environmental impact of products and promotes a circular economy. EPR regulations in India currently cover several sub-sectors, including battery waste, e-waste, tyre waste and plastic waste. The latest EPR regulations were issued in 2024. These regulations have been issued by the Ministry of Environment, Forest, and Climate Change. (Link: https://eprplastic.cpcb.gov.in/#/plastic/home)

Material Recovery Facilities (MRFs) play a crucial role in the recycling ecosystem by sorting and processing recyclable materials. These facilities receive mixed recyclables, separate them into different material streams, and prepare them for sale to end-user manufacturers. The integration of MRFs into the Extended Producer Responsibility (EPR) system enhances the efficiency and effectiveness of plastic waste recycling.

6.2.7.1 How MRF Feeds into EPR System

- Collection and Sorting: MRFs collect mixed recyclables from various sources, including households, businesses, and industrial facilities. The collected materials are then sorted using a combination of manual and automated processes. This sorting is essential to ensure that materials are separated into distinct streams, such as paper, plastics, metals, and glass.
- Plastic Characterization: Advanced technologies, such as artificial intelligence (AI) and robotics, are increasingly being used in MRFs to improve the accuracy and efficiency of plastic waste sorting. AI-powered robots can identify and sort plastic waste based on their type, color, shape, texture, and other characteristics.
- Compliance and Accountability: EPR systems hold producers accountable for the end-of-life management of their products. MRFs play a vital role in this process by ensuring that recyclable materials are properly sorted and processed.

6.2.7.2 Benefits of EPR for MRFs

- Increased Recycling Rates: EPR policies incentivize producers to design products that are easier to recycle. This leads to an increase in the volume and quality of recyclable materials processed by MRFs. As a result, MRFs can achieve higher recycling rates and reduce the amount of waste sent to landfills.
- Sustainable Funding: EPR systems provide a sustainable funding source for recycling programs. Producers are required to pay fees based on the amount and type of packaging they produce. These fees are used to support the operations of MRFs via EPR credits, ensuring that they have the resources needed to handle the increased volume of recyclables.
- Technological Advancements: The integration of EPR systems encourages the adoption of advanced technologies in MRFs. AI and robotics, for example, enhance the efficiency and accuracy of material sorting, leading to higher-quality recyclables.
- Environmental Benefits: EPR systems promote the circular economy by ensuring that materials are recycled and reused rather than disposed of in landfills. This reduces the environmental impact of waste and conserves natural resources.

6.3. Composting

6.3.1. Segment overview

The composition of MSW in India reveals that it largely constitutes more than 50% organic waste (biodegradable fraction of the MSW). Waste generated from households, especially kitchen waste, market waste (vegetables, meat, fruits, and flowers), horticulture waste, and other comparable waste are all considered to be wet waste or organic or biodegradable waste.

The chemical composition of wet waste makes it highly biodegradable and prone to immediate microbial decomposition upon disposal, influenced by a multitude of variables, such as temperature, moisture content, air/oxygen availability, sunlight, and microbes. In the absence of proper scientific management and handling,

dumping large quantum of organic waste can lead to major challenges such as generation of greenhouse gases and toxic leachate resulting in detrimental effects on air, water, and soil quality.

An estimated quantity of 75,000 TPD of wet waste is generated in the country daily. As per the national statistics published under Swachh Bharat Mission (Urban), only 68% of wet waste undergoes processing. Based on future projections, an additional capacity of 45,000 TPD is required for wet waste processing facilities out of which 30,800 TPD [16]will come from setting up of compost plants.

The process of composting wet waste entails the use of microorganisms which are required to carry out the decomposition of organic waste to produce compost. Composting is considered as the most popular, yet simple and largely adopted approach to process the huge quantum of organic waste at a household level, community level or at the city level through different methods such as windrow composting, vermicomposting, vessel composting, etc.

Even though composting is the simplest technique with lesser O&M cost and semi-skilled staff to process large quantities of wet waste, it has a high land requirement for both processing and storage. Also, the efficiency of composting municipal solid waste is directly linked with proper at source segregation of wet waste from other waste fractions. Mixed or unsegregated waste hampers the decomposition process resulting in foul odor and leachate generation, decreasing the value and quality of resources that can be derived from processing.

Compost produced from processing mixed waste leads to quality challenges in the final product. Other challenges include the long duration of composting process ~ 6 to 8 weeks, for waste stabilization and generation of final product along with seasonal variations and requirements. In addition, inadequacy of data and infrastructure pertaining to segregated wet waste collection, transportation, processing capacity and distribution of final product i.e., compost, hampers the overall planning, efficiency, monitoring and management of the complete system.

Recycling of organic waste to recover compost is ranked higher and is considered the more preferred environmental option in comparison to land disposal.

6.3.2. Scale, configuration, and project cost

Findings from operational compost plants in India with respect to scale and configuration are summarized below.

- Efficient composting process to produce quality compost is directly related to the efficacy of source segregation of wet waste generated. Preferred feedstock for composting must include a segregated fraction of wet waste which is rich in organic content.
- There are approximately 2,358 waste-to-compost plants of different capacities in India, out of which 2,285 are operational and around 73 are under construction. Two waste-to-compost plants at Nashik, Maharashtra and New Delhi, which were reviewed under this exercise are of 600 and 200 TPD capacity each spread over an area of 82 acres and 4 acres respectively.
- A windrow compost plant receiving segregated wet waste operates with the typical process efficiency of around 18-20% which is lowered to a 10-15% of compost yield wherever mixed waste is received as feedstock. In case of waste-to-compost plant at Nashik, for 600 TPD of partly segregated solid waste, 60 TPD of compost is being generated, indicating a ~20% compost yield, if 50% of the total waste i.e., 300 TPD is the wet fraction.
- Waste to compost plants following windrow composting typically have a relatively higher land footprint. A 100 TPD WtE plant (including pre-processing) requires ~1.5 acre/100 TPD waste vis-à-vis a requirement of~5 acres/100 TPD waste in case of composting plants of similar size.
- Project cost of operational waste to compost project at Nashik is Rs. 70 Cr for a plant with a waste processing capacity of 600 TPD.

Exhibit 6.7 Scale and land requirements – select Compost Plants

Parameter	New Delhi	Nashik
Technology type	Aerobic Composting	Aerobic Composting
Waste type	Mixed MSW	Partly Segregated
Waste processed	200 TPD	600 TPD
Quantity/volume of output	14 TPD	60 TPD, 180 – 200 TPD RDF
Land Available	4 Acres	82 Acres
Project cost	Rs. 15 Crore	Rs. 70 Crore

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

6.3.3. Scope, Implementation mode, project structuring and bid variable

In large-scale city level composting, only windrow composting method is adopted as other composting methods such as pit composting, vermicomposting, in-vessel composting, and organic waste converters are not capable of handling large quantities of waste, especially if unsegregated. Thus, in the following sections, composting refers to windrow composting unless specified otherwise.

In Integrated Solid Waste Management (ISWM) projects, composting is one of the components of the overall project where a single concessionaire is responsible for managing entire chain of SWM, from door-to-door collection, MRF operations, storage, processing, and disposal (SLF operations). These are usually PPP projects built on DBFOT-PPP mode with a concession period ranging from 10 to 30 years. There can be multiple small, decentralized compost plants or a single centralized compost plant in a city depending upon the quantum of waste, land availability, size of the city etc. In PPP mode, the most preferred bidding criteria in integrated projects is either lowest tipping fee or a combination of lowest tipping fee + VGF (as revenue from byproducts alone cannot recover the O&M costs). The tipping fee is recorded at the weigh bridge located at the processing cum disposal facility. Here, the tipping reflects gap funding required for entire project and not just composting operations. Some cities opt for fixed O&M fee in case of O&M service contracts; however, this is not recommended as the payment should be performance linked.

There are cities where compost plants are operated as standalone projects. These can be either PPP projects or EPC + O&M projects or simply O&M service contracts where compost plants already exist. The tipping fee is calculated based on solid waste transported up to the compost plant. The two major issues faced with standalone projects are:

1. Correspondence and coordination with multiple agencies unlike in ISWM projects.
2. Performance and revenue of compost plant operator is dependent on the performance of agency responsible for collection and transportation. For instance, inefficiency in primary collection and transportation will lead to lower tipping fee revenue of the compost plant operator. Similarly, if the extent of segregation is poor then the quality of compost will be inferior, lowering the sales revenue. This is also the reason why annuity is paid based on tipping fee model i.e., amount of waste transported to the processing facility and not on basis of the quantity of compost produced or sold (output based).

In both cases, 100% ownership of the processed byproducts usually lies with the concessionaire. Land is provided by the ULB either at free of cost or at a very nominal rate (normally Rs.1/sqm). The concession period in both standalone composting projects and ISWM projects is usually 10 years or more. Thus, a price escalation clause is incorporated in the concession agreement. Either a fixed annual price escalation of usually 3-5% is applied on the tipping fee or a formula-based price escalation is used (mostly linked to Wholesale Price Index (WPI) / Consumer Price Index (CPI).

Main obligations of ULB:

1. Providing encroachment free suitable land for setting up the facility free of cost or at a nominal rate.
2. Providing good quality segregated wet waste to the concessionaire comparable to designed capacity of the plant.
3. Timely collection and transportation of fresh wet waste to the compost plant.
4. Timely disposal of processing rejects (if in ULB's scope).
5. Timely payments to the concessionaire as per mutually agreed timelines or always ensuring sufficient funds in the escrow account.
6. Adequate support to the concessionaire in availing EC, CTE, CTO and other statutory clearances (if in the scope of concessionaire).
7. Timely payment to independent Engineer (if applicable).
8. Regular monitoring of the project.

Main obligations of the concessionaire include:

1. Ensuring the quality of civil work and machinery is in line with best industry practices.
2. Provide adequate storage area for storing processing byproducts and ensuring proper fire safety of the plant especially storage shed.
3. Construction and commissioning the plant as per agreed timelines.
4. Operating the plant as per mutually agreed service level benchmarks and ensuring best quality of processing byproducts.
5. Timely disposal of processing rejects (if in concessionaire 's scope).
6. Ensuring least breakdowns and quick corrective actions.
7. Compliance to statutory norms including air emission norms prescribed by SPCB and CPCB.
8. Handover of the Plant to ULB in good condition at the end of the concession period.
9. Timely payment to independent Engineer (if applicable).

6.3.4. Financing mix, revenue streams and commercial viability

Revenue anticipated from a compost plant should cover the following – 1) cost of depreciation of the plant (with interest); 2) asset replacement cost; 3) O&M expenses; 4) expected profit. The capital cost for erecting a Windrow compost plant in a plain terrain is typically Rs.8-12 Crore/100TPD whereas O&M cost varies from Rs. 600 to Rs. 1000 per TPD of incoming waste. Due to inferior quality of compost and inclination of farmers towards fertilizers than compost, the selling price of compost cannot be increased beyond Rs. 2 to 4/kg. With this pricing, composting becomes financially unviable and therefore VGF and/or annuity in the form of Tipping fee comes in the picture.

- **Revenue from the sale of Compost:** In bulk quantity, the compost is sold at Rs. 2000 to 4000 per MT. In most of the municipalities, dry and wet waste are processed within the same premises. A part of dry waste processing rejects from the MRF and composting rejects from the compost plant ends up at an RDF Plant. The selling price of RDF is highly variable and depends upon the location of end users. It could be Rs. 2000-3000 per tonne. The 600 TPD MSW processing plant at Nashik currently operating at 100% capacity, produces 60 TPD of compost (10% yield) along with 180 to 200 TPD of RDF (~ 30%). The operation cost of this plant is Rs. 700/MT, whereas the average annual revenue generated from the byproducts varies from Rs. 3 to 4 Crore per year (or Rs.140 to 180/MT). This implies that processing byproducts can recover only 20 to 25% of the O&M cost (or contribute to 15 to 20% of overall revenue). To recover the balance amount as well as to cover depreciation/ asset replacement required and earn a profit, compost plants, like other MSW processing plants, are heavily dependent on tipping fees.

- **Revenue from processing fee/tipping fee:** The 600 TPD waste processing plant at Nashik generates annual revenue of Rs. 17-18 Crore out of which Rs. 3-4 Crore is from the sale of processing byproducts. The remaining amount is generated through tipping fee of Rs. 953/MT which makes contribution of tipping fee as 80-85% on overall revenue. Increasing the byproduct prices will further shrink the sale of byproducts, making these projects further unviable.

6.3.5. Boundary conditions and enablers for success

- It is evident that manual segregation is more effective than segregation carried out through mechanical means. Without proper segregation, the quality of compost produced is inferior and often does not meet Fertilizer Control Order (FCO) norms. Thus, municipalities must put efforts to maximize segregation at source and ensure that the wet and dry wastes are not mixed during the collection and transportation. For example, domestic hazardous waste is toxic for bacteria useful for decomposing the wet waste.
- Small ULBs often opt for pit and vermicomposting. For large scale wet waste processing, windrow composting is opted. For many medium sized towns, building standalone windrow compost plants is often unaffordable and thus, they can alternately consider opting for cluster/regional approach for processing and disposal.
- Implementing co-treatment of municipal solid waste by mixing it with nitrogen rich waste like STP sludge, cow dung, chicken manure, spent mushroom substrate etc. to further improve the compost quality can make it more lucrative for the end users.

Exhibit 6.8 Scope, implementation mode and bid variable – select compost plants

Parameter	Delhi	Nashik
Project scope	Processing & Disposal	Processing & Disposal
Implementation mode	DBOOT	DBOOT
Capacity	200 TPD	600 TPD
Concession period	15 years	30 years
Duration operational	Defunct	6 years
Bid variable	Tipping Fee	Tipping Fee
Price escalation	Data Not Available	For first year Rs. 640 After 5 years, escalated to Rs 953 (100% for minimum guaranteed waste and 60% on balance waste)
Processing/Tipping fee	Rs. 700/MT	Rs. 900/MT
Land lease cost	-	Rs. 1/Sq.m/year

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

Exhibit 6.9 Financing mix, and revenue streams – select composting projects

Parameter	Delhi	Nashik
Capacity	200 TPD	600 TPD
Project Cost	Rs. 15 Cr. (Rehab cost; Constructed in 1981, Rehabilitated in 2007)	Rs. 70 Cr. (Commissioned in 2007)
Financing mix		
VGF (% of project cost)	No VGF	Data Not Available
Private (% of project cost)	Rs. 15 Cr	Data Not Available
Revenue drivers		
Revenue through Sale of byproducts	Data Not Available	Rs. 3 to 4 Crore/year
Processing fee	Plant Defunct	For first year Rs. 640/tonne After 5 years, escalated to Rs 953/ tonne (100% for minimum guaranteed waste and 60% on balance waste)

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

6.3.6. Case Study: Nashik Waste to Compost Plant

The Nashik Waste to Compost plant was developed in the year 2017. It has been developed and operated by M/s Nashik Waste Management Pvt. Ltd., an SPV of Mailhem Group on PPP mode with processing fee as the bid variable. The plant is equipped with a pre-processing unit which segregates the partially segregated waste into RDF, recyclables, and wet waste for final composting.

Project Snapshot

Technology type	Windrow composting technology including pre-processing
Waste type	Mixed
Design capacity	600 TPD
Byproducts generated	Compost- 60 TPD Recovered dry waste for combustion (RDF): 180-200 TPD
Land available	82 Acres
Project cost	Rs 70 Cr. | ~ Rs. 11.5 Cr./100 TPD
Project scope	Processing & Disposal Only
Implementation mode	PPP-DBFOT
Concession period	30 years
Duration operational	6+ years
Bid variable	Processing Fee
Land lease cost	Rs 1/Sq.m/year
Financing Mix	
VGF Rs. Cr. (% of project cost)	No VGF
Private Rs. Cr. (% of project cost)	100% Privately Funded
Revenue drivers	
Revenue from sale of by-products per year	Rs. 3-4 Cr.
Processing fee Rs./Tonne	Rs. 640 for first year; after 5 years, escalated to Rs 953 (100% for minimum guaranteed waste and 60% on balance waste). YoY escalation as per WPI and CPI
Reported revenue Rs. Cr. (Fin. Year)	Rs. 17-18 Cr per annum

Source: Secondary research, Interactions with ULBs / developers. KPMG analysis

Replicable project features

- **Land availability:** Encumbrance-free land of 82 acres was identified prior to the project and was bid out for setting up the project facility.
- **Guaranteed Waste Quantum:** The ULB guaranteed a supply of minimum 350 TPD waste (project designed capacity is of 600 TPD) to the facility and included a provision in the contract for providing compensation to the Concessionaire if it failed to provide the minimum guaranteed waste.

SECTION 3
ECONOMIC ASSISTANCE

7

OVERVIEW

The challenges faced by India's waste management ecosystem have grown increasingly complex over time, necessitating the progressive development and upgrading of waste management and processing infrastructure across all Indian cities. While some cities are in the initial stages of developing basic collection and segregation infrastructure, cities with populations exceeding one million confront the dual challenge of expanding this basic infrastructure to accommodate the increasing population and the resulting large quantities of waste generated, while simultaneously improving cost efficiency and resource efficiency in waste processing infrastructure and facilities.

These requirements further necessitate sustainable financing sources and a conducive environment for market linkages in terms of the supply of waste streams for MSW projects, as well as forward linkages and assurances of off-take for project outputs to enhance financial viability in the medium to long term. Encouraging private sector participation in the MSW sector is also crucial to complement government efforts and bridge the financing gap arising from the rapid expansion of waste management infrastructure.

In this context, this section of the Guidance Note focuses on providing in-depth practical guidance to city administrators on the various sources of economic and policy support offered by the Government for projects across the identified sub-sectors: Waste to Electricity, Bio-methanation, Bio-mining, and Recycling (and allied processes).

This section includes a comprehensive mapping and analysis of schemes providing economic assistance through Central Financial Assistance, Viability Gap Funding, Grants, Term Loans, etc., along with policy, administrative, and regulatory measures aimed at creating an enabling environment for the establishment, off-take, and scaling of such projects across India. A framework has been developed for the identification and thematic categorization of the various types of economic and policy assistance offered by the Government for these projects.

Towards this, the section has been organized in two parts:

- Analysis of select financing schemes providing direct economic assistance to States and cities for projects in the sub-sectors and
- Enabling policies providing support in the form of subsidies, concessions on excise/import duty, interest loan subvention and market linkages for off-take.

While there are a multitude of schemes and policies applicable, each of the schemes and enabling policy measures covered in this section have been screened basis their sizable contribution in terms of support to the States and cities. Thus, this section presents a snapshot of the complete spectrum of economic assistance that can be availed for different kinds of projects across the identified sub-sectors.

They have then been analyzed and documented in the form of concise factsheets providing key information and insights as actionable information, with the aim to aid city administrators in effectively identifying and leveraging the most appropriate measures for MSW projects in their cities. Further, this section seeks to provide city administrators with actionable information on the key steps and processes involved in availing such assistance thereby augmenting capacities to plan and finance projects at the city level.

8

DIRECT FINANCING SCHEME

8.1. Swachh Bharat Mission (Urban) 2.0

Nodal Ministry/Department

Ministry of Housing and Urban Affairs, Government of India

Brief Background

The Swachh Bharat Mission Urban was launched in 2021 with the objective of achieving a —Garbage Free— status for all India cities. The key focus areas of the Mission include:

- Sustainable sanitation to sustain the Open Defecation Status across all cities
- Solid Waste Management focusing on 100% scientific management of waste including processing and remediation of legacy dumpsites
- Used Water Management
- Information, Education and Communication for large scale citizen engagement and enabling social behavior change
- Capacity Building

The Mission provides Central Financial Assistance to States/UTs for projects and programmatic initiatives basis the action plans that States and ULBs develop and submit to avail funding.

Sub-sectors relevant to MSW

- ✓ Waste to Electricity
- ✓ Bio-methanation
- ✓ Bio-mining
- ✓ Recycling (including composting and C&D waste management)

Tenure

2021-2026

Type of economic support

Central Financial Assistance as VGF of projects

Scale of economic support offered

- Rs. 10,168 Cr for projects developed across the sub-sectors
- **Total expected project outlay:** Rs. 26,530 Cr as per MoHUA's estimation (including state matching share to Central Financial Assistance for SWM projects)

Eligible entities

All statutory towns and ULBs across 35 States/UTs (the Mission does not cover Lakshadweep)

Types of projects eligible

- Setting up of MRFs, composting plants, RDF processing facilities, plastic waste processing facilities, C&D waste processing and management facilities
- Procurement of equipment of mechanized sweeping
- Bio-mining and capping of legacy dumpsites

- Bio-methanation projects
- Waste to Electricity projects
- Transfer stations (In cities with > 5 L population)
- Sanitary landfill

Active projects across the sub-sectors relevant to MSW management that have availed SBM-U assistance include-

- **Waste to Electricity Plants**
  - Sonipat WTE: 2000 TPD processing capacity with ~25 MW power generation capacity
  - Tehkhand WTE: 750 TPD processing capacity with ~8 MW power generation capacity
- **Bio-mining/Bioremediation**
  - Deonar, Municipal Corporation of Greater Mumbai- Bioremediation of ~2 Cr MT of legacy waste
  - Ghazipur, Municipal Corporation of Delhi- Bioremediation of ~60.75 L MT of legacy waste
  - Narela Bawana, Municipal Corporation of Delhi- Bioremediation of ~1.33 Cr MT of legacy waste
  - Okhla, Municipal Corporation of Delhi- Bioremediation of ~60 L MT of legacy waste
- **MRFs**
  - Pune – MRF of designed capacity of processing 150 TPD of MSW

Financing Mix

Central Financial Assistance is matched by corresponding State share for the project fund, as prescribed below-

- 90%:10% for ULBs in NE/Himalayan States
- 100% for UTs without legislature
- 80%: 20% for UTs with legislature
- 25%: 75% for 10 lakh-plus ULBs
- 33%: 67% for ULBs with 1 lakh to 10 lakh population (both included)
- 50%: 50% for ULBs with less than 1 lakh population

The actual quantum of assistance is based on the financial requirements projected by States and Cities in the Action Plans which is subsequently scrutinized and approved by MoHUA

Pre-requisites

The following are the entry level conditions to be mandatorily complied with by States/UTs and ULBs to avail the economic assistance-

- Aligning property tax floor rates with market rates, with periodic revisions in line with Gross State Domestic Product (GSDP), as recommended by 15th Finance Commission
- Levy and collection of user charges for services provided, to recover operational costs, with periodic increase
- Adoption of Public Financial Management System (PFMS)
- All transactions will have to be made through Direct Benefit Transfer (DBT) and/ or Expenditure, Advance, and Transfer (EAT) modules, as applicable

Process for availing economic assistance

- Cities prepare a City Solid Waste Action Plan (CSWAP) as per prescribed formats detailing the proposal for SWM projects across the eligible sectors. The following are the key considerations to be accounted for by cities during the development of the action plans-

a. Conducting a holistic gap analysis based on existing levels of MSW to be managed, its characteristics, current levels of infrastructure for processing operational along with projected needs till 2026 (as per SBM-U 2.0 guidelines)

b. Requirements for the suitable upgradation and revamping of the existing infrastructure

c. Based on the gap analysis, planning needs to identify the type of facilities and the associated capacities that are needed to cater to the current and projected SWM needs.

- Accordingly, project conceptualization and project pre-feasibility reports are required to be developed
- Preference is accorded to PPP projects in WTE and Bio-methanation
- State Mission Directorates (housed in the State Urban Development Department) consolidate the CSWAPs to develop the State Action Plan
- State Action plan is submitted to the State Level Technical Committee (SLTC) and State High Powered Committee (SHPC) for technical scrutiny, validation, and approval for onward submission
- The Action Plan(s) is then submitted to MoHUA for technical scrutiny by the CPHEEO
- The approved plan(s) are then placed before the National Advisory and Review Committee (NARC) for administrative approval and sanction of funds

Challenges/limitations

- Limited allocation for Million Plus Cities (constrained to 25% of the project cost proposed).
- The allocation is further limited by constraints on the allocation to States for Central Financial Assistance. States and cities have been leveraging funds made available via XV-FC grants and PPP models that entail leasing of land at nominal rates in addition to private capital mobilization.
- The cost for projects discovered via market mechanisms while engaging contractors and DPR preparation is often found to exceed the basis of calculations made for deciding allocation to States under SBM-U 2.0.
- Following the disbursement of the first installment, release of subsequent installments is contingent on the prescribed utilization of the first tranche. Additionally, balance of the Single Nodal Account needs to be within the prescribed limits before the release of funds can be processes, even if action plans have been duly approved.

8.2. XV-Finance Commission Grants and Challenge Fund

Nodal Ministry/Department

Department of Expenditure (Finance Commission Division), Ministry of Finance, Government of India

Brief Background

The 15th Finance Commission of India (hereafter referred to as XV-FC) made recommendations for financial support to ULBs (including Urban Agglomerations and cities) via States for empowering local governments by means of Grant-in-Aid. Urban areas have been grouped into 2 broad categories:

Category 1: Million Plus Cities

Category 2: Non-Million Plus Cities

The economic support is further structured as below, for the categories of urban areas:

- **Million Plus Cities Challenge Fund (MCF):** Established as a performance linked economic support mechanism for the cities to meet municipal service level benchmarks in urban municipal solid waste management in addition to sanitation, water supply and improving ambient air quality standards.
- **Tied Grants for Non-Million Plus Cities (NMPCs):** Basic grants that can be utilized by the ULBs for any of the 18 subjects enshrined under Twelfth Schedule (includes Solid Waste Management)

- **Untied Grants for NMPCs:** For supporting and strengthening the delivery of basic services. 50% of these grants are earmarked for ~~—~~Solid Waste Management, Sanitation and attainment of Star Ratings developed by the Ministry of Housing and Urban Affairs (MoHUA)

Sub-sectors relevant to MSW covered

- ✓ Bio-methanation
- ✓ Bio-mining
- ✓ Waste to Electricity
- ✓ Recycling (including composting and C&D waste management)

Tenure

2021-2026

Type of economic support

Grant-in-Aid to State governments for ULBs including Urban Agglomerations/cities

Scale of economic support offered

Total amount recommended for 2021-2026: Rs. 1,21,055 Cr for ULBs including Urban Agglomerations/ cities. Total amount is further segmented into the following components:

Million Plus Cities Challenge Fund: Rs. 38,196

- Rs. 26,057 for meeting municipal service level benchmarks for solid waste management, sanitation and drinking water supply.

Total Grants for Non-Million Plus Cities (NPMCs): Rs. 82,859 Cr

- **Tied Grants:** Rs. 49,716 Cr
  - o Rs. 24,858 Cr for Solid Waste Management, attainment of Star Ratings by MoHUA and sanitation.
- **Untied Grants:** Rs. 33,143 Cr

Eligible entities

All ULBs and Urban Agglomerations/cities (UAs)

Types of projects eligible

Grants can be used for projects for:

- Bio-mining and capping of legacy dumpsites
- Bio-methanation plants
- Waste to Electricity plants
- Recycling
- Plastic waste processing facilities
- Waste to Compost plants
- C&D waste management plants
- MRFs
- Transfer stations
- Sanitary Landfills (SLFs)

Financing Mix

NA

Pre-requisites

The following is a summary of the conditions for eligibility for all ULBs to avail the various grants available by the different categories of cities:

- Notification of floor rates for Property Tax by states
- Linking of ULB account with PFMS
- Publishing online the annual accounts of previous year and audited accounts of year before that, by ULBs
- Notification for constitution of the State Finance Commission (where SFC is not constituted, or award period has lapsed) tabling of recommendations are available for placement in the State legislature before March '24
- Submission of detailed annual reports on measures undertaken for reuse and recycling of wastewater, rejuvenation of water bodies and water supply, by Million Plus Cities and UAs
- Million Plus Cities and UAs to annually publish 28 Service Level Benchmarks and targets
- Submission of Utilization reports for previous installments of XV-FC grants
- Submission of grant transfer certificate along with a claim for grants

Process for availing economic assistance

For Million Plus Cities and UAs

- MoHUA assesses the performance of the MPCs as per Service Level Indicators (4 for Water supply, 1 for SWM and 1 for sanitation).
- SWM service level indicator – performance in Star Rating Protocol. Level of marks based on star rating (1-star, 3-star, 5-star, or 7-star) achieved.
- Based on the marks obtained, MoHUA recommends the share of the grant to be disbursed.

For Non-Million Plus Cities

- **Tied grants:** MoHUA will assess the publication of baseline data, annual targets and achievements, utilization of funds, progress achieved in star rating protocol to determine the share of grants to be disbursed.

Based on the performance assessment outlined, MoHUA recommends the release of grants to the Dept of Expenditure, Ministry of Finance which then transfers the said grants to the State Governments. State Governments are mandated to transfer the funds to ULBs within 10 working days. Grants for MPCs are released in a single installment while those for NMPCs are released in two equal installments every year.

Challenges/limitations

- Limited traction in engagement and disbursements for MSW-based projects

8.3. Urban Infrastructure Development Fund (UIDF)

Nodal Ministry/Department

National Housing Bank

Brief Background

The UIDF has been established to augment urban infrastructure development undertaken by public/state agencies, Municipal Corporations and ULBs in Tier-2 and Tier-3 cities.

The UIDF has been designed to provide Priority Sector Lending/Loans to finance projects across areas including Solid Waste Management.

Sub-sectors relevant to MSW covered

- ✓ **Bio-methanation**
- ✓ **Bio-mining**
- ✓ **Waste to Electricity**
- ✓ **Recycling** (including composting and C&D waste management)

Tenure

Established and operationalized in 2023

Type of economic support

Loan based financing to States for eligible activities

Scale of economic support offered

Corpus of UIDF: Rs. 10,000 Cr. Launched only in 2023 and disbursements yet to be made.

Eligible entities

ULBs in the population group of 50,000- 9,99,999

- Tier 2 cities: Population between 1 L – 9,99,999
- Tier 3 cities: Population between 50,000 – 99,999

Types of projects eligible

Establishment of new/augmentation of existing Solid Waste Processing Plants

- Bio-methanation
- Waste to Electricity
- C&D waste management and processing
- RDF processing
- Waste to Compost
- Plastic waste processing

Comprehensive development of land reclaimed from legacy dumpsite remediation

Financing Mix

The rate of interest under UIDF: Prevailing Bank Rate – 1.5%

The eligible loan amount considers the size of the project and the geographical location. Percentage of project costs that can be applied for under UIDF is as below-

Size of the project	NE and Hilly States	Other than NE and Hilly States
Rs. 5-10 Cr (Rs. 1-10 Cr for NE and Hilly States)	95%	90%
>10-50 Cr	90%	85%
>50-100 Cr	85%	75%

Process for availing economic assistance

1. National Housing Bank (NHB) makes normative allocation to States.
2. States are required to prepare project proposals for eligible projects (new or ongoing) based on the allocation and obtain SLTC/SHPC and administrative approval for onward submission on the UIDF portal. The preparation for projects across the sub-sectors eligible typically entails:
   a. Gap analysis basis the current levels of waste processing and projections on growth of quantum of waste and corresponding needs for upgrading and adding facilities for processing and management
   b. Waste characterization
   c. Identification of type of facilities and associated capacities needed
   d. Identification and earmarking of land parcels for setting up the facilities proposed
   e. Identification of the mode of developing the project – PPP or EPC
3. States to prioritize projects using at least 5% of the allocation for projects wherein suitable user charges are adopted or the project can generate sufficient revenue

4. States can club small sized projects in single DPRs. The minimum and maximum size of DPRs is Rs. 4 Cr (1 Cr for NE and Hilly States) and Rs. 100 Cr respectively
5. Sanction letters with in-principal approvals issued by NHB
6. States to submit disbursement application in prescribed format
7. Mobilization advance of 20% of project loan amount disbursed within 1 year from date of sanction (mobilization advance is 30% for NE and Hilly States)
8. Remainder of the amount provided on reimbursement basis
9. Loan to be repaid by State in 5 equal installments over 7 years. Interest to be paid at the end of each quarter
10. Pre-appraisal expenses up to 0.5% of the loan amount sanctioned is permissible.
11. Contingencies up to 3% of civil works for plant and equipment are permissible
12. Centage charges are permissible if the work is executed by State-owned corporations or State-owned agencies
13. States to meet cost escalation out of own resources

Challenges/limitations

As the fund has been operationalized in July 2023, the challenges/constraints can only be anticipated at a later point in time as more States engage in the availing of this assistance.

8.4. CITIIES 2.0

The funding for CITIIS 2.0 would include a loan of Rs.1760 crore (EUR 200 million) from AFD and KFW (EUR 100 tmillion each) and a technical assistance grant of Rs.106 cr. (EUR 12 million) from the EU.

Nodal Ministry/Department

Ministry of Housing and Urban Affairs

Brief Background

City level interventions focuses primarily on Integrated waste management: Financial and technical support to up to 18 smart cities through selection of competitively selected projects promoting circular economy with focus on integrated waste management

Sub-sectors relevant to MSW covered

- ✓ Integrated Solid Waste Management project with thrust on Circular economy interventions.

Tenure: 3 Years

Type of economic support

Loan based financing to Cities and States for eligible activities.

Scale of economic support offered

Corpus of UIDF: Rs. 10,000 Cr. Launched only in 2023 and disbursements yet to be made.

Eligible entities

All 100 Smart Cities selected under the Smart Cities Mission of the Government of India are eligible to apply

Types of projects eligible

- Up to 18 projects on Integrated Waste Management
- State Level Climate Action
- Program Management and Scaling-up at National Level

Financing Mix

The program will help put into place a climate governance framework at the State and City levels as well as provide a three-tier technical assistance structure with domestic, international, and transversal experts to support capacity development for climate action in cities and States.

The program will be funded through an external funding of INR 1,866 Crore (EUR 212 million)1 viz. a loan of EUR 100 million each from AFD and KfW, i.e., a total loan of INR 1,760 Crore (EUR 200 million), and a technical assistance grant of INR 106 Crore (EUR 12 million) from the EU.

Process for availing economic assistance

The CITIIS grant amount for each project under Component 1 will be limited to 80% of the total project cost, up to INR 135 Crore (90% of the total project cost, in the case of North-Eastern and Hill States). The additional funds, i.e., 20% of the total project cost will be mobilised by the selected city through own source funding by the State/ Local Governments (10% of the total project cost, in case of North-Eastern and Hill States).

The SPVs will have to submit the general application form. Applications will be accepted through the CITIIS

Management Platform (CMP) only. No other means of submission will be accepted.

Only cities with the State Finance Department's endorsement, indicating agreement with the condition of sharing the repayment of the loan with GoI in a 50:50 ratio, will be eligible for participation in the challenge.

8.5 Urban Challenge Fund

Nodal Ministry/Department

Ministry of Housing and Urban Affairs

Brief Background

The Urban Challenge Fund was introduced in the Union Budget 2025-26 with an allocation of ₹1 lakh crore. Its objective is to transform cities into growth hubs by encouraging infrastructure upgrades and sustainable urban development.

Sub-sectors relevant to MSW covered

- ✓ The fund focuses on various urban development projects, including city redevelopment, infrastructure projects, and water and sanitation improvements

Tenure: 5 Years

Type of economic support

Loan based financing to Cities for eligible activities covering 25 percent of the total cost.

Scale of economic support offered

Allocation: Rs. 10,000 Cr.

Eligible entities

Municipalities, urban local bodies, and other government agencies involved in urban development

Types of projects eligible

- Transforming cities into economic hubs
- Creatively redeveloping existing urban spaces
- Improving water and sanitation infrastructure

Financing Mix

At least 50 percent of the project funding must come from bonds, bank loans, or public-private partnerships (PPPs)

Process for availing economic assistance

Eligible entities must submit detailed project proposals that meet the fund's criteria and demonstrate financial viability. The proposals will be evaluated based on their potential impact, sustainability, and alignment with the fund's objectives. Once approved, the projects will receive financial assistance from the Urban Challenge Fund.

9

ENABLING SCHEMES AND POLICIES

9.1. Sustainable Alternatives for Affordable Transportation (SATAT)

Nodal Ministry/Department

Ministry of Housing and Urban Affairs, Government of India

Brief Background

The scheme has been designed as an enabler for the production and off-take of Bio-CBG (Compressed Biogas) and thereby promoting generation of value and wealth from sources like Municipal Solid Waste.

The scheme includes a range of support for the producers of Bio-CBG and seeks to support the development of infrastructure for the production of Bio-CBG and a robust network of commercial agreements for ensuring a steady off-take and supply of Bio-CBG as a source of clean alternative fuel for automotive, commercial, and industrial applications.

Sub-sectors covered

Bio-methanation

Tenure

Launched in 2018

Type of support

- Assured Long Term floor pricing viz. EOI based commercial agreements with Oil Marketing Companies (OMCs) for scaling up offtake and marketing of Bio-CBG produced
- Central Financial Assistance for setting up of Bio-CBG projects by Ministry of New and Renewable Energy, Government of India
- Priority Sector Lending viz. loans offered for setting up of Bio-CBG plants
- Facilitation of loans by Public Sector Banks

Scale of support offered

The scheme has set forth a target of setting up 5,000 Bio-CBG plants with a target production of 15 MMT, across India. There are a range of measures that have been consolidated under SATAT to offer a full range of multi-dimensional support to scale up Bio-CBG plants across India. These include-

1. **Assured long term pricing**
   - Floor pricing **not lower than Rs. 46 + applicable taxes,** for procurement of Bio-CBG by OMCs. Bio- CBG to be purified as per IS 16087: 2016 Standards, compressed at 250 bar pressure and delivered to the retail outlets of the OMCs (upto 25 kms one way from the plant). Valid up to 31.03.2029
   - The Retail Selling Price (RSP) of CBG is further indexed to the RSP of CNG in the market and will vary accordingly

2. **Central Financial Assistance under the "Programme on Energy from Urban, Industrial and Agricultural wastes/residue** (FY 2021-22 to 2025-26) by Ministry of New and Renewable Energy (MNRE)

3. **Support for production of Bio-CBG (CapEx)**
    - Rs. 4.0 Cr for projects having capacity 4,800 kg/day for generation of Bio-CBG from new Bio-Gas plants
    - Rs. 3.0 Cr for projects having capacity 4,800 kg/day for generation of Bio-CBG from existing Bio-Gas plants
    - Maximum CFA of Rs. 10 Cr in both cases
    - 20% higher central financial assistance is applicable under Waste to Electricity and Biogas Programme for special category states (NE Region, Sikkim, Himachal Pradesh and Uttarakhand, Jammu & Kashmir, Ladakh, Lakshadweep, Andaman & Nicobar Islands)
4. **Support for power generation (based on Bio-CBG)**
    - Rs. 0.75 Cr/MW for generation from new Bio-Gas plants
    - Rs. 0.5 Cr/MW for generation from existing Bio-Gas plants
    - Maximum CFA of Rs. 5 Cr in both cases
5. **Facilitation of loans by Public Sector Banks**
    - **SBI:**
        - **Nature of facility:** Term Loan and Working Capital for entrepreneurs who have obtained Letter of Intent (LOIs) from OMCs under the scheme
        - **Term Loan:** Min 30% of project cost. **Repayment period:** 10-12 years
        - **Working capital:** Min 25% of project cost
    - **PNB:**
        - **Nature of the facility:** Term Loan, Working Capital and Non-Fund based limit for entrepreneurs who have obtained LOIs from OMCs under the scheme
        - **Term Loan:** Up to Rs. 100 Cr. Min 30% of project cost. **Repayment period:** Up to 12 years with moratorium period up to 24 months
        - **Non-Fund Based limit:** Min 15% cash margin
    - **Union Bank:**
        - **Nature of the facility:** Term Loan and Working Capital for entrepreneurs who have obtained LOIs from OMCs under the scheme. Bio-CBG plants of Min 2 TPD
        - **Term Loan:** Up to 75% of the estimated/actual project cost. **Repayment period:** 10-15 years but not to exceed the tenor of the off-take agreement.
        - **Working capital:** Min 25%
    - **Canara Bank**
        - **Nature of the facility:** Term Loan and Working Capital for entrepreneurs who have obtained LOIs from OMCs under the scheme
        - **Term Loan:** Up to 100 Cr. 15-25% of the project cost. **Repayment period:** 10-15 years
        - **Working capital:** Min 25%
    - **Bank of Baroda**
        - **Nature of the facility:** Term Loan and Working Capital for entrepreneurs who have obtained LOIs from OMCs under the scheme. Bio-CBG plants of Min 2 TPD

Eligible entities

ULBs in the population group of 50,000- 9,99,999

- Tier 2 cities: Population between 1 L – 9,99,999
- Tier 3 cities: Population between 50,000 – 99,999

Types of projects eligible

Establishment of new/augmentation of existing Solid Waste Processing Plants

- Bio-methanation
- Waste to Electricity
- C&D waste management and processing
- RDF processing
- Waste to Compost
- Plastic waste processing
- Comprehensive development of land reclaimed from legacy dumpsite remediation

Process for availing assistance

For availing long term floor pricing and off-take commitment mechanism

1. EOI floated by OMCs monthly
2. Entrepreneurs, plant operators and service providers to apply to the EOI through e-tendering portal
3. Evaluation and issuance of LOI by the OMC
4. Acceptance of EOI and submission of Bank Guarantee by applicants
5. Finalization and allotment of Retail Outlets (Ros) to the LOI holder
6. Signing of commercial agreement between OMC and LOI holder

For availing Central Finance Assistance by MNRE

1. Submission of proposal through the Bio-URJA Portal (Cut off: 31.12.2025)
2. Grant of in-principle approval by MNRE
   a. For projects with debt/loans from Fis/Banks: In case debt/loan drawn is equal to or more than CFA, evaluation based on appraisal of the project by the FI/Bank, Integrated Finance Division (IFD) concurrence and approval of Secretary, MNRE
   b. For projects without debt/loans from Fis/Banks: Scrutiny by the Projects Appraisal Committee, concurrence of IFD and approval of Secretary, MNRE
3. Inspection of plant performance within 18 months of commissioning of the plant. Successful commissioning would imply operation of the plant for at least 3 consecutive months including continuous operation for at least 72 hours at an average of 80% rated capacity of the plant.
4. Graded structure for release of CFA based on performance evaluation in 3 consecutive months.

Average performance achieved during 3 consecutive months	% of eligible CFA
>= 80%	100%
>= 60 % <80%	80%
>= 50% <60%	60%
<50%	0%

For availing loan instruments from Public Sector Banks

- Obtaining LOI from the OMC followed by application and processing of loans with the respective PSBs

Challenges/limitations

- The scheme and its enablers extend its scope of coverage to plants with a minimum production of 2 tonnes of gas which is typically generated by plants with a capacity of 75 TPD or more. However, MSW based projects have been found to be viable in the range of an operational capacity of 50 TPD. Thus, many such MSW based Bio-Gas plants are excluded from the remit of the scheme's benefits at present.
- The scheme has provided for an extensive framework of support for off-take but assured off-take is influenced by the successful conclusion of EOIs and Commercial agreements which are in-turn governed by considerations of proximity to Retail Outlets, availability of transmission networks to OMCs from the plant etc.
- The price determination through the EOIs and commercial agreements have been found to be lower than the market discovered rates in certain cases.

9.2. Extended Producer Responsibility (EPR)

Nodal Ministry/Department

Ministry of Environment, Forests and Climate Change, Government of India

Brief Background

Extended Producer Responsibility is a framework under the Plastic Waste Management Rules, 2016 mandating for a comprehensive management and processing of plastic waste, productive utilization of recycled plastic, enabling the creation of a market mechanism for plastic waste recycling, nudging for a shift towards sustainable alternatives for packaging and imposing fines for violating responsibilities outlined.

The guidelines comprise of obligations on the Producers, Importers and Brand Owners (PIBOs) engaged in the introduction of plastic products, and hence plastic waste in the markets. The guidelines also allow for the open market sale and purchase of EPR certificates amongst the PIBOs with the end objective of ensuring that the compliance is achieved by all stakeholders while adding a productive means of generating revenue for plastic waste processing and management.

The framework is a key enabling measure for the strengthening of the recycling and circular economy ecosystem and provides a host of benefits:

- Augments the overall collection, processing, resource recovery and utilization via recycling, and safe disposal of plastic waste
- Promotes the segregation of plastic from MSW channels
- Reduces the burden on the ULBs to collect, process and recycle and dispose plastic waste by incentivizing and enforcing obligations on PIBOs via a range of measures
- Promotes sustainability of activities by creating a market mechanism that also accrues benefits to the proactive participants in plastic waste processing
- Promotes PIBOs to shift towards alternative sustainable packaging and substitutes for plastic products
- Provides for a long-term potential for reduction of plastic waste leaking into the environment, which would otherwise go unprocessed or poorly processed
- Promotes the formalization of the plastic waste value chain

Sub-sectors covered

✓ Recycling (Plastics)

Tenure

Framework in effect from February 2022

Type of support

Policy and regulatory support mandating, incentivizing, and penalizing various sets of activities for holistic plastic waste management and processing by Producers, Importers, Brand Owners and Processors

Eligible/Target entities

- Producers of plastic packaging
- Importer of all imported plastic packaging and/or plastic packaging of imported products
- Brand owners including online platforms, marketplaces, supermarkets, retail chains other than those designated as MSMEs by GoI
- Plastic waste processors (Recyclers or other waste processors)

Types of projects eligible/Benefited

Plastic waste processing/recycling

Key features of the assistance/ Process for availing assistance

- Categories covered – Rigid plastic packaging, Flexible plastic packaging of single layer or multi-layer, multi-layered plastic packaging, plastic sheet or like used for packaging, carry bags made of compostable plastics
- All PIBOs and Plastic Waste processors need to be registered by the State Pollution Control Board or Pollution Control Committee through the centralized EPR portal developed by the Central Pollution Control Board and obtain the registration certificate
- The following aspects are detailed with the methodology for calculation of targets along with the activities in respect to plastic packaging separately for Producers, Importers and Brand Owners
  - Collection targets under Extended Producer Responsibility (Category wise targets, as applicable to be submitted by the PIBOs as part of their action plans on the CPCB portal)
  - Obligation for recycling/ reuse
  - End of life disposal
  - Obligation for use of recycled plastic content
- PIBOs can operate schemes such as Deposit Refund System or buy-back or any other model to develop robust waste streams for collection of plastic packaging
- **Generation of surplus EPR certificates, carry forward and off-setting of EPR targets and obligations, sale and purchase of EPR certificates.**
  - PIBOs who have surpassed their targets for each category of plastic waste and packaging, can utilize the surplus in the following ways
    - Off-setting previous year shortfalls
    - Carry forward to the next year
    - Sale to other PIBOs (for the same category in which surplus has been achieved)
  - PIBOs can also fulfill their obligations by purchase of relevant category EPR certificates from other PIBOs
- **Impact of EPR on MRFs and recycling revenues**
  - **Increased Volume of Collected Plastics:** EPR policies typically require producers to take responsibility

for the recycling or proper disposal of their plastic products. This leads to an increase in the volume of plastic waste collected by MRFs, as producers are incentivized to recover materials for recycling.

- **Quality of Incoming Materials:** MRFs are affected by EPR policies because they receive a higher quantity of plastics, including packaging materials. This may impact the quality and composition of incoming materials, requiring MRFs to adapt their sorting and processing methods.
- **Direct Collaboration with Producers:** EPR policies often involve collaboration between MRFs and producers. Producers may work closely with MRFs to ensure that the collected plastics meet recycling standards and can be effectively processed.
- **Channelization of Investments for technology upgradation:** MRFs need to invest in upgraded sorting and processing technology to handle the increased volume of plastics efficiently. This could include better optical sorting equipment, improved conveyor systems, and enhanced quality control measures.

Challenges/limitations

- Limitations in validation of accuracy of the data for determination of EPR targets and monitoring compliance
- Limited means of enforcement for ensuring strict compliance
- Lack of integration of the informal sector which handles a majority of the waste streams for plastic waste
- Limited levels of source segregated waste and waste leakages due to inadequate infrastructure for collection, segregation and processing/recycling and also due to lack of awareness and trained workers.

9.3. Tariff Policy, 2016 and Tariff Regulations for MSW and Biogas-based power generation

Nodal Ministry/Department

Ministry of Power, Government of India – Central Electricity Regulatory Commission (CERC), State Electricity Regulatory Commissions (SERCs)

Brief Background

These measures have focused on power generation from Bio-CBG/Bio-gas, MSW and Refuse Derived Fuel, laying the framework for promoting financial viability and expanding the scope of utilization of power from these renewable and sustainable sources. The key initiatives in this regard are as below:

1. **National Tariff Policy, 2016** by the Ministry of Power laying provisions for mandatory procurement of power based on renewable sources (including MSW, Biogas/Bio-CBG and RDF)
2. **CERC (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulation 2020** which focused on the methodology and guiding principles to be adopted for the determination of generalized and specific tariffs for Biogas based power projects, MSW based power projects and RDF based power projects.
3. **Determination of levelized generic tariff under Regulation 8 of the CERC (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulation 2020** which is an annual tariff determination to give effect to the 2020 CERC regulation
4. Various **project specific tariff determinations undertaken by the respective SERCs**

Sub-sectors covered

- ✓ Waste to Electricity
- ✓ Bio-Methanation

Tenure

- The **Tariff Policy** has been in effect from 2016
- The CERC (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulation 2020 have been in effect from 1.7.2020 to 31.3.2023
- Determination of levelized generic tariff under Regulation 8 of the CERC have been undertaken on an annual basis by the CERC – **CERC RE Tariff Order**
- The Determination of Tariffs by the respective SERCs have been undertaken on a case-to-case basis with the development and proposal of Waste to Electricity projects

Type of support

- Policy measure ensuring assured procurement of power generation viz. Waste to Electricity projects
- Regulatory orders outlining the methodology and parameters guiding the calculation and determination of tariffs for various projects related to MSW, RDF and Bio-CBG/Biogas based power generation

Eligible/Target entities

- Developers and operators of Waste to Electricity, Bio-Methanation and similar MSW, RDF and Biogas/Bio-CBG based power projects

Types of projects eligible/Benefited

- MSW based power projects
- Bio-CBG/Biogas based power projects
- RDF based power projects

Key features of the assistance/ Process for availing assistance

- As part of the amendments to the National Tariff Policy in 2016, provisions have been made for Distribution Licensee(s) to compulsorily procure 100% of the power produced from all Waste to Electricity Plants in the States

- **CERC (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulation 2020** (new/revision of regulations are yet to be promulgated for period beyond 31.03.2023)
    - Eligibility for projects
        - o Biogas based project uses new plant and machinery and has a grid connected system that uses 100% biogas fired engine, coupled with biogas technology for co-digesting agriculture residues, manure and other bio-waste as approved by MNRE.
        - o MSW based project uses new plant and machinery based on Rankine cycle technology and uses municipal solid waste as fuel.
        - o RDF based project uses new plant and machinery based on Rankine cycle technology and uses refuse derived fuel as fuel.
    - **Generic Tariff** is determined by the CERC on an annual basis for Bio-CBG/Biogas based power projects
    - **Project specific tariff** on a case-to-case basis for MSW and RDF based power projects
    - **Structure of the tariff** includes the following components – Return on equity, Interest on loan, Depreciation, Interest on working capital, O&M expenses
    - **Projects with a fuel cost component** including Bio-CBG/Biogas and RDF based projects, shall have a single part tariff with 2 components – fixed cost and fuel cost components.

- **Tariff Design**
  - **Generic Tariff** is to be determined on a levelized basis considering the year of commissioning of the project, for the **tariff period** of the project (**Tariff period** is the same as the **useful life** from date of commencement of operations. **Useful life of MSW, RDF is 20 years while that of Biogas/ Bio-CBG based projects is 25 years as mandated by CERC)**
  - Fixed cost component determined based on year of commissioning and fuel cost component based on year of operation
  - Post-tax weighted average of cost of capital will be calculated as a discount factor for computation of levelized tariff
  - Above principles also applicable to the specific tariff determination
- **Parameters for different kinds of projects**
  - **Biogas/Bio-CBG based power projects:** Capital costs, Plant Load Factor, Auxiliary consumption, O&M expenses, Specific Fuel Consumption, Fuel costs

- **MSW and RDF based power projects:** Capital costs, Plant Load Factor, auxiliary consumption, Station Heat Rate, O&M expenses, Gross calorific value, fuel costs
- **Procedure to determine and obtain levelized tariff for WTE:**
  - Project proponent has to file a petition accompanied with the project feasibility report covering the potential generation of power from the project, with the SERC
  - SERC calls for a hearing for the determination the levelized in consonance with the generalized tariff determined by CERC for the relevant category of projects
  - Typically, 2-3 hearings are conducted depending upon the nature of the case and the nature of clarifications submitted, the levelized tariff is determined and regularized for the category of projects.
  - In case the project's bid variable is the tariff, then the selected concessionaire with the ULB submit the quoted tariff petition to the respective SERC for its finalization. The order is issued by the SERC, will serve as the final tariff.
  - Thereafter, the Power Purchase Agreement (PPA) is signed with the DISCOM, with the SERC being the regulator
- SERCs are autonomous bodies that follow different metrics and calculations for the determination of levelized tariffs however the generic tariffs CERC regulations serve as the common base. As per the process defined, once the levelized tariff is determined, the levelized tariff is deemed valid for a period of 20 Years.
- The tariffs determined and set by the orders of the CERC, and SERCs play a pivotal role in determining the financial viability of the Waste to Electricity projects. The project IRR and equity IRR are needed to be in the range of 14-15% and 16-17% respectively for financially viable and sustainable projects and the tariffs determined are the basis of the revenue stream calculations by the WTE operators during the development of the project.

Challenges/limitations

- While the Tariff Orders for determination of levelized generic tariffs (covering Bio-Gas projects) have been promulgated by the CERC over successive years, the same have not been done for the project specific tariff determination covering MSW and RDF based power projects.
- The control period of the overall Tariff Determination Regulation ceased to operate with effect from 31.03.2023 and new regulations are yet to be promulgate.

10 CONCLUSIONS

This Reference Guide serves as a comprehensive resource for Urban Local Bodies (ULBs) undertaking Municipal Solid Waste (MSW) processing projects in India. It provides practical guidance on various processing approaches, including Waste to Electricity, bio-methanation, bioremediation, composting, and construction & demolition waste management, along with their associated business models. The guide also details potential economic assistance available from various Government of India (GoI) programs to enhance project viability and sustainability. By outlining successful practices and key considerations, this guidance note empowers ULBs to make informed decisions throughout the project lifecycle, from selecting the most appropriate processing method to securing financing and ensuring environmental and social safeguards. This document will enable ULBs to make informed decisions as they strive to achieve 100% scientific MSW management and transform legacy waste sites into areas for future expansion of waste management activities.

10.1. Waste to Electricity

WtE offers a promising solution for India's waste management challenges, but careful planning, project structuring, and collaboration between public and private stakeholders are essential for successful implementation. While it requires a higher initial investment and technical expertise compared to other methods, incineration significantly reduces waste volume and enables energy recovery through electricity generation. India's WtE journey has faced initial challenges due to inconsistent waste characteristics. However, recent advancements in waste segregation, pre-processing, and technology adoption have led to successful operational plants.

Despite challenges such as regulatory approvals and counterparty risks, WtE is emerging as a practical and implementable solution for municipal solid waste management in India. Key takeaways from India's experience with WtE plants include:

- Successful WtE projects require waste segregation and pre-processing to achieve a minimum calorific value for efficient incineration.
- WtE plants are most suitable for cities with a population exceeding one million and a minimum waste generation of 500 tonnes per day.
- Public-Private Partnerships (PPPs) are the preferred implementation mode, with various project structures (integrated vs. processing-only) and bid variables (tariff, tipping fee, OBI) depending on specific circumstances.
- A draft Power Purchase Agreement (PPA) can also be provided with tender documents after obtaining concurrence from respective DISCOMs.
- Financial viability relies on a combination of Viability Gap Funding (VGF), revenue from power sales, and tipping fees from ULBs.
- ULBs should provide handholding support to PPP players in obtaining statutory clearances.

10.2. Bio-methanation

Bio-methanation (CBG) offers a promising solution for biodegradable waste. The viability of these projects depends on effective source segregation and securing financing for smaller projects. The successful operational plants across various Indian cities demonstrate the viability of this technology and supportive government policies provide a clear path forward. Leveraging successful models like the Indore/ Chennai/

Pune CBG Plant, ULBs can significantly reduce landfill methane emissions, generate clean energy, and create a more sustainable waste management system. Desired salient features for successful implementation of CBG projects in ULBs are:

- Cities are encouraged to provide land to the operator at a nominal lease cost.
- Effective source segregation of waste determines efficacy of CBG plants.
- Cities can identify feedstock clusters such as agricultural markets or vegetable/fruit markets, where a large amount of organic waste is generated in a concentrated area.
- ULBs with more than 3 lakhs population can plan up to 50 TPD of CBG project.
- Pre-processing is necessary for large-scale projects to ensure the feed is consistent and homogenous.
- Structuring of these projects with balance risk sharing, guaranteed uninterrupted feed supply, bidding on VGF or Processing fee. Royality based bidding should be avoided for long term operational & financial viability of CBG projects.
- Availing guaranteed offtake for the biogas/CBG produced under SATAT. ULBs may select some other options like utilizing the same in their own fleet.
- The organic manure can be sold to fertilizer manufacturing companies, as well as directly to farmers if the market exists or State agriculture department can help developing the market.

10.3. Bioremediation

Bioremediation of legacy waste dumpsites provides an environmentally sound solution for India's legacy waste crisis. ULBs can successfully implement bioremediation projects by addressing critical aspects like proper waste assessment & characterization, earmarking sites of legacy waste, standard operating procedures, ensuring offtake of inert & RDF, and transparent cost structures. Any dumping of fresh waste must be stopped with immediate effect once waste quantification assessment is done. Case study exemplifies how meticulous planning, a well-chosen execution mode, and focus on responsible disposal of processed materials can lead to speedy land reclamation. Bioremediation presents a viable approach for transforming landfills into usable land and creating a more sustainable waste management future. It is also suggested that recovered land should be kept for future expansions of waste management facility or development of sanitary landfills.

10.4. Allied approaches

Material Recovery Facilities (MRFs) and C&D waste collection & processing facility are also primary requirement for waste management in ULBs. Managing construction and demolition waste through robust collection and recycling facilities and maximizing resource recovery through well-designed Material Recovery Facilities are key to achieve circularity in waste management system. These facilities can be operated on either on PPP or EPC model. Project structing including waste assessment in terms of quantity and quality, securing VGF to reduce capex, operational viability by fostering markets for recycled products and non-recyclable products like RDF will act as project enabler.

State & ULBs can also develop mechanism to disburse VGFs provided by different schemes (SBM U, Department of Economic Affairs, 15th Finance Commission, MNRE & CITIIS 2.0) through a single escrow account against the achievement of milestones. ULBs can also engage Transaction Advisors empanelled by DEA for timebound completion of bid process and project monitoring.

Handholding by ULBs in managing such enabling environment will encourage new operators for PPP and EPC projects in SWM sector and will successfully realize the vision of garbage free cities.

Annexure – A

Major operators in solid waste management

Waste to Electricity	
S.No	**Operator**
1	JITF (Jindal Infra)
2	RAMKY Enviro Engineers (RE Sustainability)
3	IndoEnviro India Ltd.
4	Abellon Energy Ltd.
5	Averda India Pvt. Ltd.
6	JBM Industries Ltd.
7	Blue Planet Technologies
8	Antony Waste Management Ltd.
9	Ecogreen India
10	Geron Engineering Pvt. Ltd.
11	Ever Enviro
Bio-Methanation	
1	Mailhem Ikos Environment Pvt. Ltd
2	RAMKY Enviro Engineers (RE Sustainability)
3	IndoEnviro India Ltd.
4	Excel Industries
5	Digital Utilities
6	Mahindra Green Energy
7	Blue Planet Technologies
8	Antony Waste Management Ltd.
9	Organic waste recyclers
10	Bharat Biogas Energy Ltd.
11	Ever Enviro
Bioremediation	
1	Dayacharan and co.
2	Greentech Enviro
3	Saurashtra Enviro Projects Private Limited (SEPPL) Detox Group
4	Zigma
5	Rollz India
6	Geron Engineering
7	Bhumi Green Energy
8	Alfa Therm Ltd
9	Zonta Infratech Private Limited
10	Mailhem Ikos Environment Pvt. Ltd

Annexure – B

List of projects studied

S.No	Project city	Developer
Bio-methanation		
1	Indore (550 TPD)	Ever Enviro
2	Pune (300 TPD)	Noble Exchange
3	Chennai (100 TPD)	Srinivas Waste Management Services
4	Surat (50 TPD)	Akshar Biotech
5	Solapur (400 TPD)	Organic Recycling System
6	Pune (5 TPD)	Mailhem
Waste to Electricity		
7	Delhi (2400 TPD/24 MW)	RAMKY
8	Delhi (2300 TPD/20 MW)	Jindal
9	Sonipat – Panipat (800 TPD/ 8 MW)	Jai Bharat, Maruti
10	Okhla (1950 TPD/20 MW)	Jindal
11	Jabalpur (600 TPD)	Essel Infra
12	Pimpri Chinchwad	Antony Lara
Bio-mining		
13	Delhi (50 lakh tonnes)	Greentech Enviro
14	Bhopal (11 lakh tonnes)	Saurashtra Environment Gujarat
15	Vadodara (3.75 lakh tonnes)	Zigma
16	Noida (5 lakh tonnes)	Zigma
Recycling - MRF		
17	Ahmedabad (200 TPD)	NEPRA
18	Indore (300 TPD)	NEPRA
19	Pune (100 TPD)	NEPRA
Recycling – C&D		
20	Delhi (1000 TPD)	Ever Enviro
21	Gurugram (1000 TPD)	Ever Enviro
Recycling-Compost		
22	Delhi (200-500 TPD)	IL&FS Environment
23	Nashik (600 TPD) (integrated)	Mailhem

Annexure-C

State-wise operational, under construction and planned WtE plants

A. Operational WtE plants

S. No.	State	Name of City	Designed Capacity (TPD)	Power Generation (MW)
1	Andhra Pradesh	Guntur	1200	15
2	Andhra Pradesh	Visakhapatnam	1200	15
3	Delhi	Ghazipur	1300	12
4	Delhi	Narela-Bawana	2400	24
5	Delhi	Okhla	2000	21
6	Delhi	Tehkhand	2000	20
7	Haryana	Sonipat Cluster	800	8
8	Madhya Pradesh	Jabalpur	600	11
9	Telangana	Hyderabad	2000	20
10	Maharashtra	PCMC	700	14
Total			**14,200**	**160**

B. Under construction WtE plants

S. No.	State	Name of City	MSW (TPD)	Capacity (MW)
1	Gujarat	Ahmedabad	1000	15
2	Gujarat	Ahmedabad	1000	15
3	Gujarat	Rajkot	1000	15
4	Gujarat	Vadodara	1000	15
5	Haryana	Gurgaon	2000	25
6	Karnataka	Bengaluru	600	12
7	Madhya Pradesh	Rewa	350	6
8	Maharashtra	Mumbai	600	5
9	Maharashtra	Pune	750	13
10	Telangana	Hyderabad	1400	14
Total			**9,700**	**135**

C. Planned WtE plants

S. No.	State	Name of City	MSW (TPD)	Approx. Capacity (MW)
1	Karnataka	BBMP	460	30
2	Tamil Nadu	Greater Chennai Corp.	1500	100
3	Punjab	Amritsar MC	214	14
4	Punjab	Ludhiana MC	438	29
Total			**2612**	**173**

D. Operational Bio-methanation Plants

S. No.	CBG Plants	Capacity (TPD)
1	Indore	550
2	Indore	20
3	Indore	15
4	Pune	300
5	Ambala	200
6	Chennai	100
7	Chennai	30
8	Varanasi	90
9	Surat	50
10	Tirupati	50
11	Vishakhapatnam	30
12	Hyderabad (Landfill based CBG plant)	1435

S. No.	Wet Waste to Electricity Plants	Capacity (TPD)
1	Solapur	400
2	Goa	250
3	Nashik	30
4	Vijayawada	20
5	Hyderabad	10
6	Bhopal	5
	Total	715